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POTENTIAL ALTERNATIVE TRANSPORTATION FUELS OTHER THAN METHANOL

HEARING

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES UNITED STATES SENATE

ONE HUNDRED FIRST CONGRESS

FIRST SESSION

ON THE

POTENTIAL ALTERNATIVE TRANSPORTATION FUELS OTHER THAN METHANOL

NOVEMBER 14, 1989

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POTENTIAL ALTERNATIVE TRANSPORTATION FUELS OTHER THAN METHANOL

TUESDAY, NOVEMBER 14, 1989

U.S. SENATE,
COMMITTEE ON ENERGY AND NATURAL RESOURCES,
Washington, DC.

The committee met, pursuant to notice, at 9:30 a.m., in room SD-366, Dirksen Senate Office Building, Hon. J. Bennett Johnston, chairman, presiding.

OPENING STATEMENT OF HON. J. BENNETT JOHNSTON, U.S. SENATOR FROM LOUISIANA

The CHAIRMAN. The hearing will come to order.

The hearing today on Potential Alternative Transportation Fuels is a sequel to the methanol hearing which the Committee held on October 17.[1] Today we will hear testimony about reformulated gasoline, compressed natural gas, propane, ethanol, and electric vehicles.

These are not hypothetical sources of energy. Today about 500,000 vehicles operate on compressed natural gas worldwide. About a million vehicles worldwide operate on propane. Ethanol is an octane blending agent in millions of gallons of gasoline today. Reformulated gasoline is available for sale now in Southern California. And yes, there are electric vehicles out there as well on streets, as well as golf courses.

Nevertheless, these alternative fuels displace a very small amount of gasoline, perhaps 1 percent or so. In this hearing the Committee will examine the potential for increasing the use of each of these fuels. We will examine the environmental issues, the associated energy policy questions. Although, the impetus of action in this area is environmental, what we have here, as I said in the last hearing, is a matter of national fuels policy.

I understand that the Environment and Public Works Committee will soon report out their Clean Air Act Amendments. And Senator Baucus may have a floor amendment on alternative fuels. This hearing should provide useful background to our members for floor consideration of any alternative fuel amendments. We of course reserve the right to introduce our own amendments in this area.

I look forward to hearing the views of our three panels today.

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[1] See Senate Hearing No. 101-517, "Methanol As a Potential Alternative Fuel in Our Future Energy Policy."

Before we hear from the first witness, Senator Ford, do you have any comments?

STATEMENT OF HON. WENDELL H. FORD, U.S. SENATOR FROM KENTUCKY

Senator FORD. Mr. Chairman, I look forward to the hearings. I am beginning to think we may be over-running the rabbit. There is so much push right now. And a no-growth policy seems to be emerging.

And I want to be sure that my position is one that allows us to continue to grow and be competitive without shooting ourselves in both feet.

So I look forward to the hearings and the testimony. And I was right impressed to see the re-emergence of the Ford Motor Company fuel sensor automobile they brought up here back in 1982, 1983, where it senses what is in the tank. And the car will move based on the sensor and the fuel in the tank. And I am not sure if we mandate automobiles, or mandate a certain type of fuel, how soon we are going to be able to get it to the consumer.

So a car or vehicle of that type seems to me to be something that might be an answer not on the near-term, but the long-term. And I am not for it just because it bears my name. [Laughter].

The CHAIRMAN. Thank you, Senator Ford.

Senator Bingaman.

STATEMENT OF HON. JEFF BINGAMAN, U.S. SENATOR FROM NEW MEXICO

Senator BINGAMAN. I do not have cars bearing my name, so I will skip that. But let me thank you, Mr. Chairman, for holding the hearing.

The issue of alternative fuels is very important in my home state. In particular in the Albuquerque and Bernalillo County area, we have had quite an effort, quite a responsible effort by local officials and environmental groups and others to come to grips with the pollution problem there. And part of that solution has been a mandated oxygenated fuels requirement.

I think, of course, in our state the main emphasis is on natural gas and ethanol. But, of course, we are interested in the other options as well and look forward to the testimony from these witnesses.

I think it is a very timely hearing. Thank you. I will ask to put this statement in the record.

The CHAIRMAN. Without objection.

[The prepared statement of Senator Bingaman follows:]

Statement by Senator Jeff Bingaman
Alternative Fuels
November 14, 1989

I thank the chairman for holding this series of hearings on alternative fuels. I am particularly pleased that today's hearing focuses on the broad spectrum of "clean burning" alternatives to gasoline. The need for America's cars, trucks, and buses to begin using cleaner fuels seems to be one issue upon which all public and private sector officials agree.

There are two important reasons why we should look to expanding the use of alternative fuels. One, we can reduce our steadily growing dependence on foreign sources of crude oil - the major goal of a national energy policy. Second, we can effectively reduce emissions of carbon monoxide and ozone - causing pollutants and thereby clean our air.

Far more cities are out of compliance with EPA standards for carbon monoxide and ozone than any other pollutants. Gradually converting vehicles from gasoline to cleaner-burning fuels offers one of the least intrusive means of lowering these harmful emissions levels and achieving healthy air.

NEW MEXICO

Reducing air pollution is important to my constituents in New Mexico. The City of Albuquerque and Bernalillo County had sanctions imposed in 1987 for noncompliance with National Ambient Air Quality standards for carbon monoxide. Those sanctions were lifted last year after the city implemented a vehicle inspection and maintenance program. But such sanctions cause economic hardship to the State and local government entities in non-attainment areas. More importantly, the health of citizens residing and working in the Albuquerque metropolitan area may have been compromised over the years by continued carbon monoxide pollution.

Aggressive action and coordination by the Albuquerque City Administration, the Albuquerque City Council, the Bernalillo County Commission, environmental organizations, the business community, and civic groups produced a coordinated strategy to combat air pollution and improve air quality. Part of this strategy includes a mandatory oxygenated fuels program to deal effectively with the CO problem.

ALTERNATIVE FUELS

New Mexico is not the only area of the country with an interest in improving air quality. Every state will benefit from the use of alternative fuels. I applaud the Administration for moving aggressively to promote the use of alternative fuels. The Administration's proposal would require automakers to sell 500,000 clean-fueled vehicles by 1995, rising to 1,000,000 each year from 1997 through 2004. While there may be differences of opinion over the approach taken by the Administration, I am pleased to see such a high level of commitment to the issue. I also was pleased to read that the Administration supports a "fuel neutral" approach that does not place reliance on any one alternative fuel.

Mr. Chairman, these are a number of alternative fuels to be discussed today that hold great promise. Among these most important to New Mexico are ethanol and natural gas.

Use of ethanol can lead to substantial reductions in ozone, particulates, nitrogen oxide and benzene levels. It also has the potential to reduce emissions of the greenhouse gas carbon dioxide. Additionally, ethanol is produced by fermenting corn and other grains such as wheat and barley, thus providing a new market for our agricultural crops.

Use of natural gas vehicles would result in 50-80 percent reductions in ozone-causing pollutants. Natural gas is not only clean but the American Gas Association (AGA) reports a 50 year supply of recoverable natural gas in the lower 48 states at today's prices.

The challenge for us is how to encourage the use of these fuels. One way to meet this challenge is to help create a market or alternative fuel vehicles. I have introduced legislation that will gradually convert portions of the vast federal fleet of vehicles from gasoline to cleaner-burning fuels, such as methanol, ethanol, natural gas or electricity. Fueling vehicles with these alternatives can dramatically reduce emissions of both carbon monoxide and the hydrocarbons that contribute to our ozone and particulates problem.

My legislation will require federal fleets operated in serious or severe non-attainment areas to convert vehicles running on cleaner, alternative fuels at a rate of at least 10 percent of the fleet a year, starting in 1993.

The bill also should increase the availability and use of alternative fuels and technologies, and encourage American auto manufactures to step up their production of alternative-fueled vehicles.

This legislation creates a guaranteed market with government fleets that should stimulate the automotive industry to develop and produce cleaner cars.

I understant the Environment and Public Works Committee is currently considering a fleet provision as part of the Clean Air Reauthorization.

Mr. Chairman, this hearing is timely and important. I look forward to todays testimony, and to the Senate taking action to promote the use of alternative fuels.

The CHAIRMAN. Senator Nickles.

STATEMENT OF HON. DON NICKLES, U.S. SENATOR FROM OKLAHOMA

Senator NICKLES. Mr. Chairman, I likewise would like to thank you for holding the hearings. And, I guess, this is the second day of hearings on alternate fuels.

I stated at the previous hearing that I had serious reservations about the administration proposal to mandate a million automobiles on alternate fuels. And particularly the bias that I and many others perceive in the proposal toward methanol.

I think there are some serious problems with that. And I hope that that will change. On the other alternative fuels, I hope that we can encourage development, but certainly not mandate or dictate a certain number of automobiles be built, whether there is a buyer for those automobiles or not. I think that would be a serious mistake.

I think the House has worked to improve that situation. And I hope that the Senate will do likewise. I personally think that alternative fuels, whether it is reformulated gasoline, or whether it is ethanol, as Senator Bingaman mentioned, or possibly electrified petroleum gas, or compressed natural gas there are some exciting possibilities out there.

A lot of other countries are doing a lot with propane. And maybe this country could do a lot more. I would like to encourage that. Maybe it would be in compressed natural gas. I know that some automobile manufacturers are working on that. And that is a possibility.

But this senator, at least, for one would be opposed to dictating any particular fuel. I think the marketplace should be making that decision. I think it would make a much better decision than those of us on this committee, or those of us in Congress, or even those in the administration.

Mr. Chairman, thank you. I have a statement and I will submit it for the record.

[The prepared statements of Senators Nickles and McClure follow:]

STATEMENT OF SENATOR DON NICKLES
COMMITTEE ON ENERGY AND NATURAL RESOURCES
OVERSIGHT HEARING ON ALTERNATIVE ENERGY FUELS

NOVEMBER 14, 1989

Mr. Chairman, at last month's Committee oversight hearing on methanol, I had serious concerns about the Administration's alternative fuels program in its Clean Air Proposal. At that hearing, I ststed the idea of trying to force automakers to sell a million alternative cars a year was unjust, and the Administration's biases toward methanol as the alternative fuel of choice was unwise. I am sorry that the Administration has not changed its position, but I am heartened that many Senators and Members of the House are rejecting those ideas.

Today's hearing is a great opportunity for the full range of clean motor fuels to continue to gain momentum as reasonable, near term, contributors to improving air emissions in the transportation sector. By ensuring that any clean air legislation that is passed by this Congress does not contain explicit or inherent biases for a single fuel, the whole range of alternatives is on the table for the marketplace to choose from.

Moreover, by rejecting the idea that we should mandate that automakers sell a million cars a year to a public that just might not buy them, the Congress will send the proper signals that the free market, rather than the federal government, can better sort out the best means of meeting new emissions standards.

I am pleased that more attention is being focused on some of the more obvious choices for cleaning up tailpipe emissions, particularly on cleaning up gasoline. If we can achieve significant reductions in pollution without everyone having to purchase a new car, or every gasoline station having to be replaced or rebuilt, we can achieve a lot of pollution reduction for less cost.

Compressed natural gas has come into its own as a legitimate policy option for large scale fleet applications. It has emissions and cost advantages over the competition. And there are plentiful natural gas resources in the U.S., particularly if the Congress will again permit environmentally responsible OCS development.

Propane and the LPG's are also supplies that can make a significant contribution to cleaning up transportation sector emissions. Propane is a surplus commodity in the U.S. that has a proven track record as a transportation fuel in millions of vehicle miles throughout the world. And it does not have to be imported.

I look forward to hearing the witnesses' comments on how these various fuels can contribute to cleaner air and energy security, and on what the Congress can do to reduce the biases currently distorting fuel choice.

OPENING STATEMENT
SENATOR JAMES A. McCLURE
COMMITTEE ON ENERGY AND NATURAL RESOURCES
TUESDAY, NOVEMBER 14, 1989

ALTERNATIVE TRANSPORTATION FUELS

Once again we are about to adopt environmental policies without understanding their energy policy implications -- in this instance, it is proposed that the Federal government create a new, artificial market for alternative fuel vehicles.

What our country needs instead is a well thought out, coherent, and comprehensive energy strategy designed to satisfy the needs of American consumers well into the 21st century. The goals of such an energy strategy must be: first, to clearly identify the objectives to be achieved; second, to specify in detail the means by which those objectives are to be realized; and, third, it must garner political consensus and public acceptance. In no arena is this need greater than the requirement for secure, long-term supplies of transportation fuels.

Our continued reliance on gasoline as our principal automobile fuel creates significant economic, energy and environmental consequences for all Americans. Yet rather than set out to correct this situation, the Bush Administration recently proposed an ambitious environmental program to artificially create a new market for alternative-fuel vehicles.

This proposal is not grounded in concern over trends in oil imports. Instead, this new program is prompted by the failure of about 100 areas in our country to meet the ozone ambient air quality standard mandated by the Clean Air Act.

Spurred on by this environmental concern, the proposed, Federal mandate envisions the production of 9,250,000 alternative-fuel cars over the 10-year period from 1995 through 2004.

The proponents of this new Federal program claim it is fuel neutral but it is not. Testimony received by this Committee on October 17th indicates that the Administration's proposal as formulated by the Environmental Protection Agency favors methanol over other alternative fuels. By the very act of establishment of standards based on use of M85 fuel in 1995 and M100 fuel in the year 2000, EPA will effectively dictate the fuel of choice.

Yet earlier testimony indicates that not only is methanol currently more expensive than gasoline, but it will continue to be so. More importantly, however, the methanol fuel suppliers are foreign, not domestic.

Too few people realize that today the United States is more than 50 percent dependent on imported oil and that we are more dependent than we were at the time of the 1973 Arab oil embargo. Of necessity, any

Federal mandate for the use of alternative fuels should not, indeed must not, foster greater dependence on imports.

Since the gasoline lines of the 1970's, the Department of Energy has examined several alternatives which would extend or replace gasoline supplies. Among these, alcohol fuels have received the most attention as either a "neat" fuel or in low concentration blends with gasoline. Since ethanol was provided Federal economic incentives in 1978 the production and sale of ethanol has continually climbed. In 1988, eight percent of all gasoline sold in the United States was a 10 percent gasohol blend. About 320 million bushels of corn were consumed annually to make this ethanol.

Alcohol fuels have received well deserved attention. These fuels, used as either a "neat fuel' or in low concentration blends with gasoline have proven to be effective in replacing or extending gasoline in many regions of our country. This is not only good for our national energy security and environmental quality, but it is also good for our nation's farmers.

Several other alternatives offer immediate potential environmental benefits. Among these are certain fuel additives, in particular oxygen enhancers such as methyl tertiary butyl ether (MTBE) from methanol, and a new product made from ethanol -- ethyl tertiary butyl ether (ETBE). Such oxygenated additives not only reduce atmospheric emissions but they improve automobile fuel economy as well.

Today's hearing is to receive testimony on these alternatives which include reformulated gasoline, ethanol, diesel, compressed natural gas (CNG), propane and butane (LPG), electricity and hydrogen. Each of these alternative fuels has its own unique health and safety concerns.

All alternative fuels are an important energy supply option for the United States. Their importance is enhanced because of their potential environmental benefits. Because of these dual benefits, I am looking forward to today's testimony.

The CHAIRMAN. Our first panel this morning will be Ms. Linda Stuntz, Deputy Under Secretary for Policy, Planning and Analysis of the U.S. Department of Energy.

Charles L. Gray, Jr., Director of the Emission Control Technology Division in Ann Arbor, Michigan. I take it that is with an automobile company.

Mr. WILSON. No, Mr. Gray is with the Environmental Protection Agency.

The CHAIRMAN. Environmental Protection Agency. Okay. Richard D. Wilson, Director from the Office of Mobile Sources, I assume that is also EPA, in Washington, D.C.

Ladies and gentlemen, we have 10 witnesses to deal with this morning. We would like to have time for questions, and we can do that only if you will summarize your testimony.

But proceed as you will, Ms. Stuntz.

STATEMENT OF LINDA G. STUNTZ, DEPUTY UNDER SECRETARY, POLICY, PLANNING AND ANALYSIS, DEPARTMENT OF ENERGY

Ms. STUNTZ. Thank you, Mr. Chairman.

I am happy to have the opportunity to appear before you today to discuss the Department of Energy's views on alternative fuels. We certainly welcome the committee's interest in this matter. We think it fundamentally affects energy policy as well as environmental policy.

Using alcohol fuels, to start there, including methanol and ethanol reduces reactive hydro-carbon emissions. These are the hydrocarbon emissions that react in the atmosphere with nitrogen oxides to produce smog.

Ethanol, as you know, is currently produced in the United States primarily from corn and other crops or food products. If ethanol is to be produced at a more competitive price, it will be necessary to use lower valued feed stock, such as wood or waste products to produce that ethanol.

The Department of Energy is working very aggressively to try and develop this technology. As it now stands, we think it is probably a post 2000 effort in any realistic way.

Now, since alcohol is a liquid hydro-carbon fuel similar to gasoline, alcohol-powered vehicles are more similar to the gasoline powered vehicles we are familiar with today. Fuel flexible methanol or ethanol vehicles could be put into commercial scale production as soon as model year 1995. Now these vehicles could operate on ethanol up to 85 percent, that is, 85 percent ethanol and 15 percent gasoline.

The technology for dedicated alcohol vehicles, those that would run exclusively on alcohol is less developed right now than fuel flexible vehicles, largely because the market demand for those vehicles has not been there, which is because the fuel is not available. Nobody wants to put themselves in a situation where they have got to depend upon getting alcohol.

Engine designs have to be changed to take full advantage of methanol or ethanol's high octane and other combustion characteristics. But we do not foresee any serious technical impediments to developing dedicated vehicles that would run on blends of ethanol or methanol up to 85 percent.

Vehicles that would run on 100 percent alcohol fuels would require further technical development. There are problems with cold weather starting. Although there has been only preliminary analysis done, it appears to us that the cold weather starting problems are less severe for ethanol than they are for methanol.

Turning to CNG and propane, as has been commented already, those vehicles are in use throughout the world and, indeed, in this country. We estimate there is something in the neighborhood of 30,000 CNG vehicles on the road right now. They produce hydrocarbon emissions that are less reactive in the atmosphere and, therefore, cause less smog.

Natural gas vehicles use natural gas which is provided by local distribution companies similar to the manner that homes are heated. Liquid petroleum gas and propane are produced as a byproduct either to natural gas production, or to petroleum refining.

The cost of CNG and propane vehicles could be substantially reduced, if they were manufactured by original equipment manufacturers. Currently, most of those vehicles that we talked about that are already on the road are designed as retrofits. That does increase the cost. It reduces the efficiency and some of the benefits of using these technologies.

Electric vehicles depend—the emissions characteristics of electric vehicles depend, of course, on what the—what source of electricity is used to charge the batteries. If that electricity is generated from coal fired plants, the electric vehicles have one set of emission characteristics. If it is generated from hydro-electric or from CNG fired plants, the electric vehicles would have a different set of emissions characteristics.

Operation of the vehicles themselves produces no significant emissions.

Reformulated gasoline refers to gasoline whose composition has been changed to achieve more benign emission characteristics. Although this is a relatively new development in the area of petroleum refining, and we have much to learn yet about how these reformulations will be done. Indeed, there are new configurations being announced, literally, everyday.

Someone told me last week that the industry buzz word for these is designer gasolines. Generally they will involve reducing aromatic content and increasing oxygen content, such as MTBE or ETBE, which are the ethers of methanol and ethanol. So there is a relationship between the alcohol fuels I talked about earlier, and many of the reformulated gasolines that we are seeing.

Because aromatics are reduced, we do expect reformulated gasoline can help reduce urban ozone formation and may provide other health benefits, such as toxics reductions. We are seeking as a department to advance alternative fuel technology in several ways.

As I mentioned earlier, we are working to produce ethanol and methanol from wood and other low cost bio-mass material, such as garbage. We are also continuing to work on producing methanol from coal, especially, in conjunction with the production of electricity from gasified coal.

We are working to improve electric vehicle technologies, particularly, basic research on batteries. These efforts are directed toward reducing vehicle cost and increasing range and performance.

We are doing this because, as you all know, the transportation sector is 98 percent dependent on petroleum and petroleum derived fuels. Alternative fuels such as methanol and ethanol, CNG, electricity, and propane have the potential to enhance both our technical options and our market options in volatile world energy markets.

We have issued a series of reports concerning the costs and benefits of alternative fuel use. We will be releasing other reports in the near future.

With that, let me await you for your questions.

[The prepared statement of Ms. Stuntz follows:]

STATEMENT

OF

LINDA G. STUNTZ

DEPUTY UNDER SECRETARY FOR
POLICY, PLANNING AND ANALYSIS

U.S. DEPARTMENT OF ENERGY

BEFORE THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

UNITED STATES SENATE

NOVEMBER 14, 1989

INTRODUCTION

I am happy to appear before this committee today to discuss the use of alternative motor fuels in transportation. I recently provided testimony to you that focused on the use of methanol. This testimony provides similar information about compressed natural gas (CNG), ethanol, electricity and reformulated gasoline. All of these fuels could be used in the Clean Fuels Program proposed by the President.

COMPARISON OF FUELS

Let me first address the environmental impacts of these alternative fuels relative to conventional gasoline.

Alcohol Fuels - Alcohol fuels (methanol and ethanol) have similar effects on the environment. The carbon monoxide (CO) and nitrogen oxides (NO_x) emissions produced by neat alcohol vehicles and gasoline vehicles are similar. Although total hydrocarbon (HC) emissions from neat alcohol vehicles are roughly equal to those of modern gasoline vehicles, HC emissions from neat alcohol vehicles are largely composed of unburned alcohol and, therefore, produce less ozone in the atmosphere than emissions from gasoline vehicles. However, neat alcohol vehicles can produce greater aldehyde emissions than gasoline vehicles. Comparing methanol to ethanol, ethanol vehicles produce slightly higher levels of non-alcohol HC emissions than methanol vehicles. However, using ethanol is expected to have very similar benefits in reducing ozone formation as using methanol. The ozone reducing benefits of using pure ethanol or methanol (E100 or M100) are significantly reduced when either fuel is blended with 15% gasoline (E85 or M85).

The amount of carbon dioxide (CO_2) released by using these alternative fuels will depend upon several factors including: the type of feedstock used to produce the fuel; the type of process used to produce the fuel; and the energy sources used both for feedstock and fuel production. If natural gas is used as the feedstock for methanol, slight reductions in CO_2 are provided by using methanol in vehicles compared to using gasoline. Larger reductions in CO_2 are possible by using ethanol since ethanol has less fossil fuel energy embodied in it, per gallon, than methanol. Biomass (e.g. grain, trees, etc.) derived fuels tend to reduce CO_2 emissions, relative to fossil fuels, because carbon is absorbed from the atmosphere by crops as they are grown. These CO_2 emission reduction benefits could also result from methanol use, in the future, if biomass derived methanol becomes economically competitive.

Natural Gas - Natural gas vehicles (NGVs) generally produce higher HC, at least 50 percent lower CO, and roughly similar NO_x emissions relative to gasoline vehicles. The composition of HC emissions from NGVs differs markedly from gasoline vehicle HC emissions. A large part of HC emissions from NGVs is methane, which produces less ozone in the atmosphere than HC emissions from gasoline vehicles. While methane is a greenhouse gas, the overall impact of the use of NGVs on greenhouse emissions is positive.

Propane/Liquefied Petroleum Gases - Emissions from propane-powered vehicles are similar to those of NGVs. A large part of HC emissions from propane vehicles is propane, which also produces less ozone in the atmosphere than the HC emissions of gasoline vehicles.

Electricity - The only significant emissions of electric vehicles (EVs) are the emissions released during the production of electricity used by EVs. The characteristics of these emissions depend on the type of generating capacity used to produce the electricity. The emissions produced by EV batteries are not a significant concern.

Reformulated Gasoline - "Reformulated gasoline" refers to gasoline whose composition has been changed to achieve more benign emissions, whether those emissions come from the tail pipe of the vehicle, or from fuel evaporation. There are, as yet, no standards for reformulated gasolines since this is a recent and rapidly developing area. Also, reformulations are being targeted towards different vehicle types. Therefore, even when more fully developed, there are likely to be different types of reformulated gasoline.

It is expected that, in general, reformulated gasolines likely will have lower vapor pressures (volatility), reduced aromatic content, and higher oxygen content relative to current gasolines. Such reformulated gasolines would produce lower benzene emissions and ozone-producing HC emissions relative to those from current gasoline. While the developing state of reformulated gasoline prevents us from predicting the degree of environmental benefit they may provide, we expect that reductions in aromatics and olefin content could lower the HC constituents that are particularly reactive. Consequently, reformulated gasolines have the potential to reduce urban ozone formation.

A reformulated gasoline has been recently introduced by ARCO for use in vehicles that would otherwise use leaded gasoline in California. ARCO is working on two other reformulated gasolines for use in later-model vehicles with emission catalysts and other emission control technologies. The Sun Co. will also be testing several reformulated gasolines for use in later-model vehicles. In addition, the American Petroleum Institute has recently announced a joint program by the automobile and oil industry to develop and test reformulated gasolines as well as other fuels.

It is difficult to estimate U.S. refinery capacity to produce reformulated gasolines because we do not yet know their composition and how they will be produced, particularly in large quantities. DOE will assess the capabilities of U.S. refineries to produce reformulations as new information is developed. It is expected that market demand will cause increased production of oxygenated additives such as MTBE or ETBE. However, the increased availability of butanes resulting from newly established EPA gasoline vapor pressure controls should help expand the capacity to produce oxygenates. Use of these additives is likely to increase if gasoline is reformulated.

FEEDSTOCKS FOR FUELS

Alcohol Fuels - As discussed in my recent testimony before this Committee, the most likely feedstock for methanol is natural gas in remote locations that have large gas reserves in relationship to local demand. In the longer term (past 2000), methanol may also be produced from biomass or coal depending on the relative economics of production and environmental considerations. DOE is pursuing research on producing methanol from both biomass and coal with the goal of reducing cost and improving efficiency.

Ethanol is currently produced in the U.S. from corn and other crops or food products. Ethanol is also produced in other countries from a variety of crops. Brazil, for example, uses sugar cane. In the future, it may be possible that ethanol could be produced more competitively using lower valued feedstocks such as wood or waste products. DOE is conducting extensive research to advance ethanol production technologies and reduce production costs.

Natural Gas - NGVs use natural gas which could be provided by local gas distribution companies. This gas is almost exclusively derived from North American production.

LPG and Propane - LPG and propane are produced as a by-product to natural gas production and petroleum refining. Increased demand for these fuels to serve the transportation market could be met in three ways: diverting LPG from some of its current uses, for which natural gas or petroleum products would substitute; increased production from petroleum refining; or increased imports. Increased production of LPG from domestic natural gas would be possible if natural gas production increased. However, increased LPG demand would not, in itself, stimulate increased natural gas production.

Electricity - Electricity is produced from a wide variety of energy sources including hydroelectric, nuclear, coal, natural gas, petroleum and advanced renewable technologies. The fuel source for electric vehicles will depend on local conditions and recharging cycles. It is likely that EVs will use a relatively high percentage of baseload power because most recharging will take place at night.

Reformulated Gasoline - Reformulated gasoline would be produced from petroleum. As discussed above, we are studying the refinery requirements to produce reformulated gasoline. It is possible that the average product yield per barrel of crude petroleum may change. Consequently, production of reformulated gasoline may increase or decrease U.S. oil use.

COMPARISON OF VEHICLES

Alcohol Vehicles - Since alcohol is a liquid hydrocarbon fuel similar to gasoline, alcohol powered vehicles are similar to conventional vehicles. Few changes to existing vehicles need be made to produce vehicles that operate on alcohol (M85 or E85) or gasoline. Several manufacturers have developed fuel-flexible vehicles that can operate on either gasoline or methanol (M85) or ethanol (E85). Both Ford and General Motors have provided several fuel flexible vehicles to the State of California for its alternative fuels demonstration program and hundreds more are scheduled for delivery. Fuel-flexible, methanol (M85) or ethanol (E85) vehicles could be put into commercial scale production by model year 1995.

The technology for dedicated alcohol vehicles is less developed. Engine designs have to be changed to take full advantage of methanol's or ethanol's high octane and other combustion characteristics. Serious technical impediments to developing dedicated vehicles that operate on M85 or E85 and take full advantage of the high octane of each of these fuels are not expected. These vehicles are expected to offer either higher performance, or higher fuel economy, or some combination of higher fuel economy and performance as compared to a fuel flexible vehicle operating on alcohol (M85 or E85). However, dedicated alternative fuel vehicles may not be accepted by general consumers until there is widespread availability of alternative fuels.

For vehicles that can run on M100 (dedicated or flexible) more work on cold weather starting is needed. The low volatility and high heat of vaporization make starting on M100 difficult, particularly in cold weather. Various methods have been tried to overcome this but none is ready or available for production. We believe this starting problem can be overcome with further engineering development. While there has been less testing of vehicles operating on E100 than M100, it appears that the use of E100 poses less of a problem with cold weather starting compared to M100.

CNG and Propane Vehicles - CNG and propane light duty vehicle technology has had a long development history and is well proven in certain markets in the U.S. and in several other countries. About 30,000 vehicles are operating on CNG in the U.S. and refuel at about 300 existing refueling outlets. This experience has shown that, compared to equivalent gasoline vehicles, CNG vehicles tend to have lower maintenance costs and similar fuel economy.

Currently, CNG and propane vehicles are built by retrofitting existing gasoline powered vehicles. For CNG vehicles, these retrofits typically cost between $1500 and $2500. Propane conversions are less expensive because of the lower cost of fuel tanks. The cost of CNG and propane vehicles would be substantially reduced if they were manufactured by an original equipment manufacturer (OEM). DOE estimates that current technology OEM CNG vehicles would cost about $800 more than comparable gasoline vehicles if manufactured in high volumes. Vehicles may be redesigned to more effectively accommodate CNG tanks to provide comparable driving range. Such redesign could increase our estimated cost. While DOE has not estimated the cost of OEM propane powered vehicles, it is likely that the cost would be lower due to less expensive fuel tanks.

The manufacture of OEM CNG and propane vehicles would also provide opportunities to advance the vehicle technology. Recent work on emissions control and performance promises to result in significantly improved vehicles. One research area concerns the fact that gaseous fuels, such as CNG, make less air available to the engine. Consequently, an engine of equal size operating on CNG tends to have lower performance than a vehicle operating on gasoline. This is a problem that can be overcome with engineering development (perhaps using turbocharging). Work is also required in the development of lightweight CNG and propane fuel tanks.

Dedicated light-duty CNG and propane vehicles pose no additional technical problems. As noted earlier, however, the market acceptance of dedicated vehicles would be limited unless fuel availability became widespread. One advantage provided by a dedicated vehicle, relative to a dual fueled vehicle, is more trunk space or storage space, since two fuel systems are not required.

Heavy-duty CNG engines and vehicles have been developed in part through the Department of Transportation's program to encourage transit companies to purchase alternative fuel vehicles. Many transit operators have expressed strong interest in CNG powered buses, in addition to methanol powered buses. Consequently, extensive development efforts have been made and production-ready technology is either available or soon will be. The two CNG powered buses provided by Columbia Gas to operate in Columbus, Ohio are examples of advanced CNG heavy duty vehicles. Earlier vehicles provided by Brooklyn Union Gas in New York City also contributed to engine and vehicle development.

Electric Vehicles - Electric vehicles are also at a production-ready stage, for markets in which the still high cost, limited range, and lower performance are acceptable. Further advances in battery cost and performance are likely to improve the competitiveness of electric vehicles with general purpose gasoline powered vehicles. DOE has been responsible for many of the recent improvements in electric vehicle performance and is continuing to develop advanced batteries and vehicles.

ALTERNATIVE FUEL USE AND ENERGY POLICY

The Department of Energy (DOE) has been studying alternatives to petroleum-based fuels for some time because of the transportation sector's near total dependence on oil plays a crucial role in U.S. oil import dependence. Oil use by the transportation sector in 1988 exceeded 10 million barrels per day, up more than 2 percent from 1987, and almost 20 percent higher than in 1973. Transportation oil use alone exceeded U.S. production of petroleum in 1988 by 900 thousand barrels per day. Even if we assume substantial energy conservation, fuel switching in industry and buildings, and cars achieving fuel economy above 40 miles per gallon by the year 2000, we estimate that U.S. oil use will remain at about the same level for the next 10 to 12 years. Since domestic oil production is expected to decline, even extraordinary conservation efforts will not prevent increased dependence on imported oil.

Alternative fuels such as methanol, ethanol, CNG, and electricity have the potential to enhance our options in the frequently volatile world energy markets. Fuel-flexible and dual-fueled vehicles would also allow consumers to choose among competing fuels. Other sectors of the economy (electricity generation, for example) have benefitted from this flexibility. But, transportation remains almost entirely dependent on oil.

U.S. energy security could be enhanced by having fuel flexibility between gasoline or diesel fuel and domestically produced fuels such as natural gas or electricity.

VEHICLE AND FUEL DISTRIBUTION COSTS FOR THE CLEAN FUELS PROGRAM

In testimony provided recently to this Committee, I provided estimates of the costs and volumes of methanol required by the President's Clean Fuels program if the nine affected urban areas used fuel-flexible vehicles operating on M85 to comply with the program. This was merely an analytic assumption with which to provide estimates to the Committee and is not a projection of what the President's Clean Fuels Program will be. With this same qualification, we have produced similar estimates of satisfying the requirements of the President's Clean Fuels Program using all CNG vehicles and all electric or hybrid vehicles (EHVs). Hybrid vehicles (HVs) have a small gasoline engine which provides power to the electric motor. We assumed use of HVs, in addition to EVs, for these calculations, because their increased range and performance may help achieve consumer acceptance in certain markets.

Separate estimates of the incremental cost of vehicles and refueling outlets have not been made for the use of ethanol because the costs of vehicles and service stations for use of neat ethanol (e.g. E85) would be very similar to those estimates made for neat methanol. Use of ethanol may provide some cost savings relative to methanol since it is less corrosive and would be compatible with existing gasoline storage tanks.

The fuel-flexible methanol-gasoline vehicles assumed in our estimate would operate on any combination of M85 and gasoline. They would likewise operate on any combination of E85 and gasoline. The volume of ethanol required (276 thousand barrels per day in 2004) would be somewhat lower than required for methanol (362 thousand barrels per day in 2004) because of the higher energy content of ethanol compared to methanol.

For convenience, DOE's estimates of the additional cost of fuel flexible alcohol vehicles and methanol refueling outlets are repeated: The minimum number of refueling outlets dispersing methanol (or ethanol) that would be required is 1,500 by 1995, 12,000 by 2000, and almost 20,000 by 2004. As required under the President's Program, 500,000 light duty vehicles are required by 1995, 750,000 by 1996 and 1 million in 1997 through 2004. Using DOE's estimates of costs for methanol refueling outlets, and the additional costs of fuel flexible vehicles, the following costs would be incurred. These costs do not include any additional infrastructure needed to provide fuel to service outlets such as methanol terminals or tank trucks.

Cumulative Costs of Alcohol Fuel Flexible Vehicles
and Methanol Fuel Distribution Outlets
($ Millions)

Year	Additional Vehicle Cost	Refueling Outlets
1995	140	70
2000	1400	540
2004	2500	820

NATURAL GAS REQUIREMENTS AND CNG VEHICLE AND FUEL DISTRIBUTION COSTS

If the Clean Fuels Program were satisfied by using CNG vehicles (again - an analytic benchmark which is not intended to be a projection of how this program would actually be implemented), in the first year of the program (1995), 110 million standard cubic feet (SCF) per day natural of gas would be used in CNG vehicles displacing 21,000 barrels per day of gasoline in the 9 cities affected by the program. By the year 2000, natural gas use would increase to 850 million SCF per day displacing 162,000 barrels per day of gasoline and, by the year 2004, the last year of the Clean Fuels Program, this figure would increase to 1.3 billion SCF per day displacing 244,000 barrels per day of gasoline.

The approximate minimum number of refueling outlets dispensing CNG that would be required is 500 by 1995, 3,700 by 2000, and 5,600 by 2004. As required under the President's Program, 500,000 light duty vehicles are required by 1995, 750,000 by 1996 and 1 million in 1997 through 2004. Using DOE's estimates of costs for CNG refueling outlets, and the additional costs of OEM CNG dual fueled vehicles, the following costs would be incurred. These cost estimates do not account for the estimated 300 existing refueling outlets, several of which may be located in the nine urban areas. Also, these costs do not include any additional distribution pipelines needed to provide natural gas to the refueling station.

Cumulative Costs of CNG Vehicles and Fuel Distribution Outlets
($ Millions)

Year	Additional Vehicle Cost	Refueling Outlets
1995	400	150
2000	4,200	1,200
2004	7,400	1,800

ELECTRICITY REQUIREMENTS AND EHV VEHICLE AND RECHARGING COSTS

If the Clean Fuels Program were satisfied by using EHVs (again - an analytic benchmark which is not intended to be a projection of how this program would actually be implemented), in the first year of the program (1995), 8.1 gigawatt hours per day of electricity would be used by EHVs in the 9 cities affected by the program. By the year 2000, electricity use would increase to 83.0 gigawatt hours per day and, by the year 2004, this figure would increase to 140.6 gigawatt hours per day. EHV's displacement of petroleum, relative to other alternative powered vehicles, depends on several factors, including the percentage of travel they are driven in ozone nonattainment areas, the relative number of HVs compared to EVs, changes in use-patterns of non-EHV vehicles of an EHV household, and the degree to which gasoline power is used in HVs. Using a very specific set of assumptions pertaining to these parameters, we estimate that the EHV vehicles estimated to fulfill the President's Clean Fuels Program would displace 11,000 barrels per day of gasoline in 1995 increasing to 113,000 barrels per day in 2000 and 192,000 barrels per day in 2004.

Each EHV is expected to require its own recharging unit due to the length of time required for battery charging. The total number of charging units required will equal the number of vehicles or 500,000 by 1995, 5.2 million in 2000, and 8.8 million in 2004.

Using DOE's estimates of the incremental costs of EHVs over conventional vehicles and the costs of recharging units, the following costs would be incurred:

Cumulative Costs of EHVs and Recharging Units
($ Millions)

Year	Additional Vehicle Cost	Recharging Units
1995	2,900	250
2000	30,000	2,600
2004	53,000	4,400

ROLE OF DOE TO ASSIST IMPLEMENTATION OF CLEAN FUELS PROGRAM

The Department of Energy, in cooperation with several Federal Agencies, intends to develop additional information on alternative fuel characteristics and performance. DOE is leading a comprehensive interagency assessment of all alternative fuels. This assessment is being conducted in the context of the Interagency Commission on Alternative Motor Fuels, which is chaired by the Deputy Secretary of Energy. We will take account of existing State, local, and private fleet demonstrations as well as existing alternative fuel fleets in DOE, the Department of Defense and the U.S. Postal Service. We are moving rapidly to establish a common data base with which to evaluate the performance and emissions characteristics of these vehicles. Thus far, we have received excellent interest and support from States, localities, and private companies when we have discussed various components of our alternative fuel evaluation. Our discussions have revealed a strong consensus that the Federal government should provide a common format for data collection and evaluation.

As we move forward in establishing this data base, and developing the Federal alternative fuel vehicle demonstration programs required by the Alternative Motor Fuels Act, we will be acquiring important new information. This information, and the conclusions reached by this Commission and its advisory body, the U.S. Alternative Fuels Council, will be provided in annual interim reports in 1990 and 1991. These reports, and a final report due by September 30, 1992, will help us chart the best national policies on alternative fuels and to assist the EPA Administrator in implementing the President's Clean Fuels Program.

This concludes my prepared remarks. I would be happy to answer any questions that the committee may have.

The CHAIRMAN. Thank you very much, Ms. Stuntz.

Mr. Gray.

Mr. WILSON. Mr. Chairman, if it is all right. I will do it.

The CHAIRMAN. Mr. Wilson, yes, please.

Mr. WILSON. Thank you.

STATEMENT OF RICHARD D. WILSON, DIRECTOR, OFFICE OF MOBILE SOURCES, ENVIRONMENTAL PROTECTION AGENCY, ACCOMPANIED BY CHARLES L. GRAY, JR., DIRECTOR, EMISSION CONTROL TECHNOLOGY DIVISION

Mr. WILSON. Before I get into a brief discussion about the other alternative fuels under consideration, I thought it might be useful to have a brief summary of why these alternative fuels are getting so much attention in terms of environmental benefits.

As you know, we have most of our major cities in the country now in nonattainment for ozone pollution better known as smog, which hydro-carbons from motor vehicles represent about 50 percent to 60 percent of that smog forming emissions.

In addition, each year more people drive more cars more miles, which continues to make the problem worse. And for our major cities we have few additional options other than cleaning up car emissions even further than we already have.

In addition, mobile sources account for nearly half of the air toxic emissions emitted every year in the U.S. today.

We have focused primarily on adding control technology to vehicles in the past, and now think it is also time to look at cleaning up the fuels as well in order to get cars that are much lower in emissions that we have had in the past.

There are two types of alternative fuels being considered. One type are fuels that are added to gasoline in order to run in cars now in use, and in order get lower either toxic emissions or carbon monoxide emissions generally. These fuels are methanol, ethanol, MTBE and ETBE. Both ethanol and MTBE being the two most popularly used. And several cities, as Senator Bingaman mentioned, Albuquerque being one are using these fuels to deal with their carbon monoxide problems.

In addition, we are talking about replacement fuels that would be used instead of gasoline or diesel fuel. These include ethanol, CNG, methanol, LPG, electricity and substantially reformulated gasoline, which would get 30 percent to 40 percent reduction in ozone and toxics in the near-term and 80 percent to 90 percent reductions in the long-term.

The President's Clean Air Act proposal had really three different pieces dealing with the use of replacement fuels. This first chart I would like to show briefly summarizes the President's program, as it would introduce cars running on fuels other than gasoline and diesel fuel into the marketplace.

It would require that roughly 30 percent of the cars sold in the nine worst ozone cities in the country be designed to run on these alternative fuels.

The first, I guess, key point I would like to make is the President's proposal was, in fact, fuel neutral. We would intend to set the emission performance standards of the types shown here for

1995, a 30 percent reduction in reactive hydro-carbons, a 40 percent reduction in air toxics. And by the year 2000 an 80 percent and 90 percent reduction.

These standards we think can be met by all of the fuels we will be talking about today. And we would expect the marketplace to make the decisions as to which of the various alternative fuels would be used in what segments of the market. We would expect several probably to be used.

We would make sure that the fuels would match the cars. A program similar to the introduction of unleaded gasoline in the country in the mid 1970s following the introduction of catalytic control devices on cars.

In addition to this program the President's proposal also included requirements for new urban buses to run on alternative fuels beginning in 1991. And also a requirement that cities with the worst carbon monoxide air pollution reformulate their gasoline to include oxygenated fuels to lower those CO emissions from cars.

In addition other parts of the bill would require that gasoline be changed in most of the country to lower volatility and would require us to look at the air toxics coming from existing gasoline and make by regulation their control of those air toxic emissions as well.

Now to briefly talk about the various fuels under consideration in addition to methanol that we talked about last week. First of all reformulated gasoline, as I mentioned, we have been reformulating gasoline somewhat over the past several years. We have taken lead out of gasoline, in part, due to its toxic effects and in part due to its incompatibility with catalytic devices used to control emissions from cars.

We have also—introduced volatility controls this last summer. And, as I mentioned, several cities are using oxygenated fuels in order to deal with winter time carbon monoxide problems. There is much more that can be done with changing gasoline, reducing its volatility further, or removing benzene and aromatics and removing reactive gasoline compounds.

This could drastically lower the emissions from gasoline vehicles. Some of those changes could be—the gasoline with some of those changes could be used on existing vehicles increasing the speed at which the reductions were achieved. And perhaps some of the changes required to meet the kind of standards shown on the chart would require vehicles designed specifically for that fuel.

Turning now to ethanol, ethanol is the primary fuel used in Brazil. It has the advantages of being a liquid fuel. It is high octane and high performance. It is compatible not only with engines designed for ethanol, but also engines designed for methanol and has very low emissions as well.

Probably the main disadvantage is it presently costs more than gasoline and some of the other alternative fuels that will be discussed. Its key use now as an oxygenated blend in future use would likely be as a component to reformulated gasoline as well as an expanded use of the oxygenated blends that I talked about. And perhaps in the longer term, as a neat fuel as well, if research provides lower cost production capabilities.

Turning now to compressed natural gas there are——

Senator NICKLES. Before you do that, you mentioned it cost more. On each one of these alternatives would you give us the cost differential as say compared to gasoline.

Mr. WILSON. Compressed natural gas.

Senator NICKLES. What about ethanol?

Mr. WILSON. Ethanol costs roughly $1.10 to $1.20 a gallon to produce. There is presently a federal excise tax allowance on ethanol sales, which amounts to essentially 60 cents per gallon of ethanol use, which makes it competitive with gasoline in terms of a gasoline extender, or an oxygenated blend in areas that require that oxygenated fuel to be used.

As a neat fuel it is roughly twice as expensive as gasoline now and roughly twice as expensive probably as methanol. Longer term there is a fair amount of research being done, including with the Department of Energy to look at cheaper ways of producing ethanol.

And all this interest in alternative fuels, I think will spur some of that research too.

Senator NICKLES. It is twice as expensive as gasoline, but you said the cost was $1.10 per gallon? Something like that?

Mr. WILSON. Yes. The wholesale level of gasoline is roughly 55 cents, 60 cents a gallon wholesale level. But that is before taxes and distribution cost.

Turning to compressed natural gasoline briefly, as I mentioned there is something 30,000 CNG vehicles being used in the U.S. and many more in Italy and New Zealand and other countries. It is a high octane fuel as well. And it has very low emission. And it is very cost competitive with gasoline as a fuel today.

The disadvantages of CNG are that it takes relatively heavy tanks on the vehicle in order to hold the fuel. It adds weight to the vehicle and uses up space. Also, presently most, if not all, of the CNG vehicles in this country are conversions from gasoline vehicles. Those conversions are relatively expensive, in the order of $1,000 to $2,000 per vehicle.

All in all I think CNG is particularly an attractive fuel now for use on centrally fueled fleet vehicles. And it is getting a lot of attention in that area in fleets and urban buses.

Liquefied petroleum gas, again, there are hundreds of thousands of vehicles in this country and more in Japan and Holland, Italy. It is a liquid high octane fuel. It also has very low emission. And it is very cost competitive as is CNG with gasoline.

The disadvantages are that it is generated as part of the refining process. And the supply may be limited to the extent of thinking of LPG as a general replacement for gasoline. But again, it is a particularly attractive fuel for urban fleet vehicles, and it is being looked at more and more along those lines.

Finally, electricity has a number of advantages that Ms. Stuntz mentioned. It has essentially no emissions from the vehicle itself. And emissions at the power plant generating the electricity can be relatively easily controlled.

But its disadvantages are the limited range and performance of the vehicles. Refueling is time-consuming and again, additional research will be necessary before the use of electric vehicles beyond fleets is likely to be seen.

In summary, clean air is a serious long-term problem that is more and more difficult to deal with. Clean fuels we think are a critical part of the solution to that air pollution problem. As I mentioned the President's proposal is fuel neutral. All of these fuels that I have talked about today can meet the kind of performance standards we have talked about. And the winners will be determined by the market.

We are confident that all these fuels have good emission performance characteristics. We are in the process of developing individual reports on each of them. We have issued one now on methanol. And we are well along on reports on ethanol and CNG and LPG and electricity. And we will provide the committee with copies of those reports as soon as they are finished.

In closing, just last Tuesday U.S.A. Today published a consumer poll on alternative fuels, which was in the paper and this chart is a blow-up of that poll. It is kind of interesting to find out that, I guess, the public is ahead of us, if not with us in the interest in alternative fuels. Fully 68 percent of the people polled said that car-makers should be required to build cars that run on alternative fuels. And over 50 percent of the people were willing to pay more for those cars.

So, I think there is a growing interest in terms of alternative fuels, and the public is joining that interest.

Thank you very much.

[The prepared statements of Mr. Rosenberg and Mr. Wilson follow:]

TESTIMONY OF
WILLIAM G. ROSENBERG
ASSISTANT ADMINISTRATOR FOR AIR AND RADIATION
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

NOVEMBER 14, 1989

Mr. Chairman and Members of the Committee, I am pleased once again to be given the opportunity to discuss the clean alternative fuels program that the President has included in his comprehensive Clean Air Act Amendments of 1989. At your hearing four weeks ago most of the discussion centered on the use of methanol as a motor vehicle fuel. Today, I would like to address five other candidate clean alternative fuels: reformulated gasoline, compressed natural gas, liquified petroleum gas, ethanol, and electricity.

I would like to begin by briefly summarizing the role that vehicle emissions play in our urban ozone problem. As of 1988, 101 urban areas exceed our health standard for ozone, which can impair lung function and damage lung cells. Ozone is not emitted directly, but is a product of a series of complex atmospheric reactions involving hydrocarbons, nitrogen oxides, and sunlight. While nitrogen oxides emissions control is important in some areas, EPA believes that for most urban areas hydrocarbon control is the most promising strategy for reducing ozone. Even with the major improvements in automotive emissions control of the last two decades, motor vehicles still account for 50 to 60 percent of all hydrocarbon emissions in many of our most severely polluted urban areas but in others to a lesser degree.

A second important urban air quality problem is toxic air pollution. Toxic air pollution involves a large number of different compounds emitted by a variety of sources that can cause cancer, respiratory disease, and birth defects. Motor vehicles account for just over 50 percent of all toxic air problems. The most important air toxics from motor vehicles are particulate matter, benzene, butadiene, gasoline organic matter, and formaldehyde.

It is important to note that to date most of the efforts by the federal government and the private sector to reduce vehicle emissions have focused on engine and emission control system design. Now there is a developing consensus that we must also pay attention to the fuels themselves if we want to continue to reduce vehicle emissions in a cost-effective manner.

It is helpful to distinguish between two groups of alternative fuels. One group includes those fuels that are composed of conventional gasoline and low levels of additives that can reduce certain emissions. One significant advantage of such fuels is that because they are so similar to conventional gasoline, current vehicles need no modifications to operate on them. The gasoline additives that have generated the most interest are ethanol and methanol and the corresponding ethers, ethyl tertiary butyl ether (ETBE) and methyl tertiary butyl ether (MTBE). The latter is used widely throughout the U. S. All of these additives contain oxygen, and thus, tend to reduce carbon monoxide emissions in cars designed to operate on straight gasoline. MTBE and gasohol are currently being used in several cities such as Denver, Phoenix, Tucson, Las Vegas, and Reno as a carbon monoxide emission control strategy. To the degree that they replace octane-enhancers such as benzene, these additives can also decrease air toxics emissions. They do not provide major reductions in hydrocarbon emissions, however.

The second group of alternative fuels that could be used as replacement fuels for conventional gasoline are methanol, ethanol, compressed natural gas, liquified petroleum gas and electricity. The optimum use of these fuels could be in new vehicles entering the fleet that are specifically designed to take advantage of the combustion properties of these fuels. Reformulated gasoline also has the potential to reduce emissions and could be used in new and possibly existing vehicles providing this benefit. It is these replacement fuels that offer the largest ozone and toxics emissions reductions and are the focus of this hearing and the President's clean alternative fuels program.

The President's clean alternative fuels proposal is designed to be fuel neutral; in order to clarify this point I would like to briefly describe the proposal. The program requires that metropolitan areas of 250,000 people or more with ozone levels of 50 percent or more above EPA's ozone standard be included in the clean alternative fuels program. Based on the most recent ozone data, the following nine cities would be included: Los Angeles, Houston, New York City, Milwaukee, Baltimore, Philadelphia, Hartford, San Diego, and Chicago. Automobile manufacturers would be required to produce, distribute, and offer for sale 500,000 clean alternative-fueled vehicles in 1995, 750,000 such vehicles in 1996, and 1,000,000 clean alternative-fueled vehicles in each year from 1997 through 2004. Vehicles would qualify as clean alternative-fueled vehicles if their emissions met the emissions performance standards that EPA would establish by a rulemaking process. We have previously testified that we would aim for a set of emissions performance standards that would provide 30 to 40 percent reductions in both hydrocarbons and toxics in the near term and 80 to 90 percent reductions in both hydrocarbons and toxics in the long term. Automobile manufacturers would be free to sell any combination of fuel and vehicle technology that meets these standards. State/local governments would assist to make clean fuel economical to owners.

EPA would require the availability of the fuels needed by these vehicles. High-volume service stations in these 9 areas would be required to offer at least one clean alternative fuel for sale beginning in 1995. In addition, EPA would retain the authority to extend the fuel availability requirement to major nationwide corridors when vehicles dedicated to clean alternative fuels began emerging. Market incentives are provided throughout the program in order to maximize flexibility and effectiveness: individual cities can opt into or out of the program, or include more vehicles, if certain conditions are met. Automobile manufacturers and fuel suppliers can meet their requirements through emissions trading and banking and fuel pooling as long as the hydrocarbon and toxics emissions reductions are equivalent to those that would have been achieved with the clean alternative fuels program.

In a separate requirement, clean alternative fuels would be phased-in for new transit buses in metropolitan areas of 1,000,000 population or more based on the following schedule: 10 percent of sales in 1991, 25 percent of sales in 1992, 60 percent of sales in 1993, and 100 percent of sales in 1994 and later model years.

I must emphasize, as I did in my testimony four weeks ago, that the President's proposal is absolutely fuel neutral. EPA would establish the emissions performance standards described above, and any fuels that can meet these standards would be eligible to fulfill the requirements of the program. It is impossible to say at this time which fuel or fuels would be utilized, but we believe a number of fuels are worthy of attention including reformulated gasoline, methanol, ethanol, compressed natural gas, liquified petroleum gas, and electricity. We discussed methanol in the previous hearing and I would now like to address each of the other candidate fuels.

The concept of reformulated gasoline is now receiving considerable attention. Reformulated gasoline clearly offers some significant benefits in that it could probably be used in all vehicles, not just new or converted ones, and would not require changes in the fuel distribution and retail infrastructure. The critical questions are what level of emissions reformulated gasoline can provide and the costs of such a reformulation. As of yet no oil company has submitted a specific proposal that can be evaluated in terms of costs and benefits.

It is important to note that EPA has already implemented certain regulations that have resulted in changes to gasoline. The lead phasedown and unleaded gasoline programs in the 1970's and the recent gasoline volatility controls are the most well-known examples. We believe that a reformulated gasoline which would by itself provide the necessary environmental benefits would have to include, at minimum, major additional reductions in gasoline volatility, large decreases in the use of aromatics such as benzene, toluene, and xylene, and further shifts in refinery operations to delete the more photochemically reactive gasoline compounds. These significant changes could add increased costs to gasoline. We look forward to working with the oil industry to identify and evaluate the potential for reformulated gasoline to contribute to future emission reductions. From an energy supply perspective, the use of reformulated gasoline would maintain our reliance on petroleum for our transportation fuels.

Ethanol's physical and combustion properties are very similar to those of methanol. It is an excellent engine and vehicle fuel in that it is a liquid, high-octane, high-performance fuel. Cars that would be designed for methanol would be able to operate well on ethanol and vice versa. Although there has been limited testing of pure ethanol vehicles in the U.S., we believe that ethanol vehicles have the potential to provide the same ozone and toxic air emissions reductions as methanol.

Although Brazil's transportation system runs predominantly on ethanol, there has been much less interest in ethanol as a replacement fuel for gasoline in the U.S. because of cost and supply limitations. In this country ethanol is produced by fermentation of corn and other grains. Ethanol currently sells for approximately $1.18 per gallon, which is nearly twice as much as the energy-equivalent price of gasoline. Accordingly, interest has focused on ethanol's use as a gasoline additive only where it benefits from federal and state motor vehicle fuel excise tax policies. Biomass-based ethanol does offer potential to reduce the emissions of global warming gases and increase domestic energy security in the long term if technological breakthroughs occur with respect to supply and cost.

Natural gas is, of course, used extensively in the U.S. for residential and commercial purposes. Since it is a gas, it must either be compressed or liquified in order to store the fuel on-board a vehicle. At this time, compressed natural gas (CNG) is the favored route. As a vehicle fuel, CNG has some attractive properties, for example, it has extremely high octane. It is also very attractive from an emissions standpoint: its primary hydrocarbon emission, methane, has negligible photochemical reactivity, its toxic emissions are extremely low, and its gaseous state reduces carbon monoxide emissions during cold start and warm up, when gasoline emissions are highest. In 1988, EPA tested a number of CNG vehicles in a cooperative program with the American Gas Association. Based on the results we are certain that CNG vehicles could meet and quite possibly exceed the emissions performance standards that we would expect to set under the President's proposal.

The biggest concern with CNG is on-vehicle storage. Even when compressed, 4 to 5 times more space is needed to store CNG on-board a vehicle to be able to travel the same distance as a vehicle does on a tank full of gasoline. And the CNG must be stored in sturdy tanks that are relatively heavy and expensive. The tradeoff is that with a small CNG tank, vehicle range can be relatively low, while adding more tanks to increase range will also add weight which will decrease vehicle performance and efficiency as well as trunk space. Research is underway to improve CNG storage.

There are approximately 30,000 CNG cars in the U.S. today, many owned by natural gas utilities, and hundreds of thousands of cars in Italy and New Zealand. Nearly all of these have been aftermarket conversions that permit the vehicle to operate on either CNG or gasoline. Since these vehicles have two entirely separate fuel systems, they typically cost $1000 to $2000 more and have a relatively limited range on CNG. We believe that CNG, like other alternative fuels, would be best suited for engines and vehicles designed and optimized for CNG only. This would bring the incremental cost and weight of CNG vehicles down, though some tradeoff between range and performance/efficiency/trunk space/cost would still exist. Many have concluded that CNG is best suited initially to centrally fueled fleet vehicles where refueling is simplified and range is not so important.

We are currently investigating the economic and other issues associated with widespread use of CNG as a vehicle fuel. Relatively low vehicle fuel demands could clearly be met with domestic natural gas. Domestic gas itself is less expensive than gasoline on an energy basis, although the high level of compression that is necessary to store it on the vehicle adds somewhat to the final fuel cost.

Liquified petroleum gas (LPG) is another fuel that is used for a variety of purposes in the U.S. It is composed of a mixture of gases that is stored as a liquid in sealed tanks under moderate pressures on-board a vehicle. Like CNG, LPG is a high-octane fuel, and it too offers the potential for ozone, toxics, and carbon monoxide emissions reductions. We recently tested an LPG vehicle obtained through the National Propane Gas Association that demonstrated low emissions characteristics.

LPG vehicles are used throughout the world, particularly in Japan, Italy, and Holland. There are several hundred thousand LPG vehicles in the U.S. As with CNG these are nearly all dual-fueled vehicles converted from gasoline-only operation.

The primary limitation with more widespread use of LPG is supply. LPG is a byproduct of natural gas extraction and petroleum refining, so the current supply is very competitive with current gasoline prices. But if LPG were to be adopted as a major vehicle fuel, the much larger demand would require refinery modifications to make LPG which would increase its cost. Based on these supply and cost limitations, LPG is likely to be used predominately as an urban fleet fuel.

Electric vehicles offer much promise from the standpoint of the urban environment. Since the power for vehicle propulsion comes from batteries charged with electricity from central power plants, engine emissions are zero. Of course, depending on the feedstock used to produce the electricity, emissions occur at the power plant, but these can generally be efficiently controlled and are often outside of the urban area. It is important to note that some electric vehicles have used small auxiliary engines for heating and/or air conditioning, and the emissions from these engines would need to be considered. But, theoretically, these functions could be powered by batteries as well.

Unfortunately, battery technology has not yet advanced to the point where electric vehicles satisfy the full range of consumer needs. Range is still relatively low, cost is high and performance is generally less than that of a comparable gasoline vehicle. Refueling, i.e., recharging the batteries, still takes much longer than refueling a liquid-fueled, or even a gaseous-fueled, vehicle. The Department of Energy maintains an ongoing R and D program in this area, and we would expect that electric vehicle performance will be improved in the future, especially if a real market opportunity is established for such vehicles through adoption of the President's proposal.

EPA has committed to a series of reports detailing the environmental and economic impacts of each of these candidate clean alternative fuels. We have already delivered the report on methanol to the Committee, and we are now in the process of preparing similar reports on ethanol, compressed natural gas, liquified petroleum gas, and electricity. We are relying on the Department of Energy and other federal agencies for much of the information concerning fuel production and cost. We hope to begin a similar report on reformulated gasoline when more information becomes available.

In closing, I would like to again emphasize the fuel neutrality of the clean alternative fuels program. Once we set the emissions performance standards, it will be up to the marketplace to determine the "winners". We would expect a number of fuels to be adopted,.depending on vehicle application and region of the country.

I will be pleased to answer any questions that you might have.

TESTIMONY OF
RICHARD D. WILSON
DIRECTOR, OFFICE OF MOBILE SOURCES
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON INVESTIGATIONS AND OVERSIGHT
OF THE
COMMITTEE ON PUBLIC WORKS AND TRANSPORTATION
U.S. HOUSE OF REPRESENTATIVES

November 9, 1989

Mr. Chairman and members of the Subcommittee, I am very pleased to be given this opportunity to discuss with you certain aspects of H.R. 3030, the "Clean Air Act Amendments of 1989." These proposed amendments to the Clean Air Act reflect the extensive and determined efforts of President Bush and the Executive Branch agencies, as well as the important legislative work done by the Congress in recent years.

As you know, Mr. Chairman, the President's legislative initiative was introduced in both houses of the Congress and is currently in the midst of the legislative process. As a result, I am to some extent addressing a moving target this morning. I intend to restrict my remarks primarily to the President's bill, as introduced (H.R. 3030).

The President proposed the Clean Air Act Amendments of 1989 in response to the nation's concern about the need for stronger and more effective control of air pollution. Despite its success in limiting emissions of certain air pollutants, the Clean Air Act that was enacted in 1970 and amended in 1977 has serious shortcomings and needs to be updated: it underestimates the measures needed to control urban smog, an air pollution problem shared by virtually all U.S. cities; it does not provide an effective mechanism for control of emissions of toxic air pollution; and, it does not sufficiently limit emissions of acidic air pollutants to protect natural ecosystems from the effects of acid rain.

The President's clean air proposal would make substantial and quantifiable improvements in air quality and would make them quickly. Under the proposal, most cities would attain national ambient air quality standards for ozone and carbon monoxide by the turn of the century, and all cities would attain those standards during the following decade. Emissions of toxic air pollutants nationwide would be cut substantially, reducing hundreds of cancer-related illnesses each year. And acid rain would be cut by nearly fifty percent by the turn of the century. The President's bill also includes important changes to ease implementation, minimize bureaucratic paperwork, and enhance enforcement.

Mr. Chairman, as you requested, I intend to limit my remarks today to those issues contained in the President's proposal which relate to matters within the jurisdiction of this Committee. The areas that I will address in my testimony include: discretionary sanctions on highway funding and new drinking water hook-up sanctions; alternative fuel requirements (which could reduce fuel tax collections); conformity; and marine vessel loading and unloading.

DISCRETIONARY HIGHWAY FUNDING AND NEW DRINKING WATER HOOK-UP SANCTIONS

The Clean Air Act has always included various sanctions that EPA could implement if States failed to meet certain commitments. There have been some questions in the past about when and how sanctions should be applied. The Administration's bill clarifies this matter by explicitly stating that sanctions should be used "for the purposes of encouraging the State to undertake reasonable efforts and preventing further deterioration of the State's air quality."

Under the President's bill, if an incomplete State Implementation Plan (SIP) is submitted or if the SIP is disapproved, and if EPA finds that the State is not making reasonable efforts to correct the deficiency, EPA must propose one or more of four discretionary sanctions. These sanctions include: a moratorium on the construction or modification of major stationary sources; a cutoff of most federal highway funding; a ban on most new drinking water hook-ups; and withholding of at least some air pollution control program grants.

If the State still does not correct the deficiency within six months after sanctions have been proposed, EPA must promulgate one or more of the sanctions, which would take effect within 60 days of promulgation. States would therefore have eight months to correct any deficiency following EPA's initial proposal of sanctions.

The choice of which sanction or sanctions to apply is discretionary with the EPA Administrator. H.R. 3030 directs the Administrator to "describe why application of such sanction or sanctions is appropriate under the circumstances."

The Administration's proposal limits the application of highway sanctions by indicating that these sanctions could only be applied where the Administrator believes that attainment and maintenance of the standards cannot reasonably be achieved without inclusion of transportation control measures. The President's bill also limits the application of highway sanctions in a nonattainment area to once in each of the five-year periods beginning with the date of enactment.

You have expressed an interest in hearing about the impact of past highway sanctions resulting from the current Clean Air Act. Since 1980, EPA has imposed highway sanctions in seven States. In five of these, the sanctions applied to just one urban area. Sanctions were in effect for less than two months in three of the seven States and for less than two years in two of the remaining four. To date the sanctions have delayed few highway projects and a small percentage of total federal highway dollars in each area. The threat of sanctions and sometimes the broader ramifications of not complying with the Clean Air Act--as opposed to the actual financial impact of sanctions--seem to explain the effectiveness of highway funding restrictions in causing nonattainment areas to comply with the statute.

The highway sanction provision is a major reason why Inspection and Maintenance (I/M) programs have been implemented in sixty-four urban areas in thirty-one States. I/M is a primary State control measure for reducing in-use vehicle emissions. Since 1980, I/M programs have resulted from highway sanctions proposed or imposed in ten States.

The one new discretionary sanction added by the Administration's bill would allow the Administrator to prohibit any public water system regulated under Title XIV of the Public Health Service Act from providing drinking water to any new structure in all or a portion of a nonattainment area. This sanction, which was adapted from the Group of Nine's bill (H.R. 99), would not prohibit a public drinking water system from providing water service to any customer requiring such service to correct an existing public health hazard.

In completing my remarks on sanctions, I wanted to point out that the President's bill proposes the elimination from the current Act of the sanction on funding for the construction of sewage treatment works.

ALTERNATIVE FUELS

In H.R. 3030 and S. 1490, as introduced, the Administration proposed a Clean Fuels Program that would require the introduction of 9.25 million clean-fueled vehicles from 1995 to 2004 into areas with the worst ozone problem. These vehicles could emit far less ozone precursors than those operating on conventional gasoline.

This raises the question of whether the introduction of such vehicles would impact the Highway Trust Fund. To date, all of EPA analyses of the Clean Fuels Program have assumed that new fuels would be subject to fuel excise taxes on an energy-equivalent basis. Current law does not now provide such tax treatment. However, if new fuels are equitably taxed on an energy basis, the use of clean fuels, as proposed in the Administration's bill, should not affect the overall revenues of the Highway Trust Fund.

Proposed Clean Air Act amendments for carbon monoxide nonattainment areas that prescribe a fuel oxygen content have the potential to decrease Highway Trust Fund revenues. Gasohol is only one of the potential oxygenated fuels and it has been getting a substantial subsidy since 1979. The Administration proposal does not prescribe a specific oxygen content level since this is left to the State/ local government. If the requirements of the State/ local government result in an increased use of gasohol, Trust Fund revenues would decrease because gasohol is exempt from six cents per gallon of the federal tax. The current usage of gasohol reduces Highway Trust Fund revenues by about $500 million per year. EPA will defer to the Department of Transportation (DOT) to provide more detailed information on this subject.

CONFORMITY

The Administration's Clean Air Bill makes no changes to the conformity requirement in the current Clean Air Act. In regard to transportation, this provision requires federally-approved and financed plans, programs, and projects to "conform" with SIPs. Assurance of "conformity" of transportation actions to the SIP is an affirmative responsibility of the DOT Secretary and each local metropolitan planning organization with jurisdiction over the actions.

Existing procedures for implementing the conformity requirement, developed by DOT and EPA in 1980-81, remain in effect. These procedures, as implemented over the past eight years, have focused on insuring the implementation of transportation control measures in SIPs and have not adversely affected highway or transit programs in a significant way.

MARINE VESSEL LOADING AND UNLOADING

An important part of the President's proposal for bringing all areas into attainment for ozone is the development of control techniques guidelines (CTG)--national guidance and other federal measures for source categories which emit volatile organic compounds (VOC). The EPA would select source categories that are significant national sources of VOCs and are located in a variety of States. Because of EPA's expertise and experience, the Agency can move relatively quickly to develop consistent national guidelines. These efforts will help support the States in achieving emissions reduction goals in the proposed amendments. CTGs set a national benchmark and create consistency across the country in the control level required for selected industries, and they enable States to take advantage of EPA's technical expertise in standard setting.

The loading and unloading of marine vessels is one example of the need for these national rules that may be of interest to the Committee. These operations can be a significant source of VOC emissions in many ozone nonattainment areas. If the standards vary from State to State, vessels would have to install a variety of different and incompatible equipment to comply with different State rules. A national standard, as called for in the President's proposal, would allow vessels to be fitted for one type of control equipment that would be required in all areas. Having one national standard also facilitates the development of regulations by the Coast Guard to ensure the safety of the equipment and the operations which are to control the VOC emissions.

Mr. Chairman, thank you for the opportunity to address the Subcommittee. I would be pleased to answer any questions that you or the members may have.

The CHAIRMAN. Thank you, Mr. Wilson.

The automobile companies, as I understand it, want to go into the research program for ETBE but the oil companies are not yet convinced of that. Is that correct? Either one of you. And if so, do you think that that should be the subject of increased activity on research.

Ms. STUNTZ. Sir, I know you will hear from some witnesses later from those companies. My understanding is that the story on ETBE is whether or not it will—is economics.

It is an ether, its qualities are fairly well understood. It is similar to MTBE in many respects except in cost. And in order for it to be considered a cost competitive option, either as an additive for oxygenated fuels, or in some other application, it would need to have extended to it the type of tax incentives that are available for ethanol from which it is made.

And the administration has recently kicked that matter back to the Congress for your consideration on whether that should be done. No decision has been made by the auto companies or the oil companies—that I am aware of that this should not be considered, that research should not be done on it. It is a matter of cost right now.

The CHAIRMAN. Well, they have not decided, as I understand. We will hear from them later. You do not have an opinion on whether they should or should not do that?

Ms. STUNTZ. I think it should be considered. I think the more options that we have, particularly——

The CHAIRMAN. When you say considered, it should be the subject of research or should not?

Ms. STUNTZ. Yes, sir.

The CHAIRMAN. Do you agree with that, Mr. Wilson?

Mr. WILSON. Yes, sir. ETBE like MTBE is an additive to gasoline that can lower carbon monoxide emissions and bring octane to gasoline without the use of aromatics that create toxic air pollution.

So we think using ethanol in the form of ETBE is environmentally better than using it as it is now as gasohol. Yet it is not being used as ETBE, because it cannot get the same tax advantage when it is used as an ethanol blend.

The CHAIRMAN. By the way the Secretary of Agriculture, Mr. Yeutter is strong on ETBE. He writes a little postscript, "I am quite high on the potential of ETBE. I will be glad to come and testify on it." So, the Secretary is strong for it at least.

Now it seems to me that reformulated gasoline is a here and now technology. ARCO has had their great PR releases on it. Is it widely available now? What are the down sides of reformulated gasoline?

Mr. WILSON. Senator, as I mentioned in testimony, to some extent we have been reformulating gasoline for a number of years for environmental and other than cost reasons. We have proposed and will soon make final a rule-making to require the volatility of gasoline to be greatly reduced, improving air emissions.

We are looking at the toxic emissions from gasoline and may well be moving forward with rules to deal with the aromatic content of gasoline as well.

The CHAIRMAN. What would the cost of that be?

Mr. WILSON. Well, the cost of volatility controls will tend to be a penny or two a gallon. To some extent some of that cost is saved, because the fuel will not evaporate from the cars as quickly and can be used as fuel.

The control of aromatics depends on the extent to which they are controlled. And that is an issue that we are now gathering more information on to determine if we should proceed with the rulemaking.

Developing fuels that can compete as a low emission alternative fuel, we think, you can do that with gasoline too. That will take——

The CHAIRMAN. Well, I am not pushing, I am not pushing the ARCO thing. But, I mean, they just happened to have gotten the coverage. But what would their formulation do? What does it cost additionally? And what does it do in terms of aromatics, et cetera for this?

Mr. WILSON. In their formulation they lower the volatility by about a pound if I recall correctly. They added some oxygenates to the blend. And they also slightly lowered the aromatic contents.

I suspect it is in the range of a penny or so a gallon in terms of what the extra cost of producing it would be.

The CHAIRMAN. And it costs a couple of cents more a gallon as I understand it.

Mr. WILSON. Yes.

The CHAIRMAN. Does that go as far as it should go, reformulated gasoline or not?

Mr. WILSON. Well, I think it is a good start. And Arco is doing it voluntarily, which I think they should be commended for. Having said that, it essentially is gasoline that will meet the kind of oxygenate and volatility standards that we are moving forward to require by regulation of all fuels.

So in the end—it is a good first step—and probably needs to go further.

The CHAIRMAN. When would you come up with your regs?

Mr. WILSON. Well, we hope to have our regulations on volatility out early next year. And we have already had the proposal on those regs.

The CHAIRMAN. So the Congress need not legislate with respect to reformulated gasoline. You are going to take care of that?

Mr. WILSON. Well, we have significant authority in the present Clean Air Act to control the properties of gasoline to the extent they affect emissions of air pollutants into the atmosphere.

The CHAIRMAN. You do not need any encouragement from the Congress?

Mr. WILSON. No, we are moving forward, I think, pretty aggressively ourselves.

The CHAIRMAN. Well, that is good because the figures I have seen, particularly with the old cars, that through reformulated gasoline you can get more immediate pay-off for less money and more quickly with reformulated gasoline than with any of these other things.

Mr. WILSON. Absolutely, Senator, you are quite right in that regard. As we were putting together the President's Clean Air proposals we tried to take that into account by looking both at near-term and long-term emission reduction programs.

In the near-term changing the quality of gasoline is one of the few things you can do that have an immediate pay-off. In the longer term, those old cars are no longer going to be in the road by the year 2000 or so. And so when you are looking at what the problems would be then, you need to look at other solutions. But in the near-term, you are quite right.

The CHAIRMAN. Mr. Wilson, your testimony indicates that more than half the air toxics problems come from automobiles. Yet EPA and the states seem to have focused on stationary sources including refineries, as a way to control air toxics.

The oil industry seems to be offering you a way to get at air toxics quickly by reformulated gasoline. Now, if refineries reduce air toxics by producing reformulated gasoline, why should they not get credit for that in meeting the air pollution requirements for the refinery itself?

Mr. WILSON. Well, I would have to look at a particular suggestion in that regard. As I mentioned, in addition to looking for controls on the refinery itself, we are already looking at the toxic emissions coming from gasoline and looking at regulating the aromatic content, for example, of gasoline.

In addition, while there has been a lot of attention on the emissions, for example, of benzene from vehicles and the role that gasoline plays, many of the controls that we have required to be put on the vehicles, the catalytic converters, and the evaporative control devices and the like also deal with those toxic emissions.

So while the toxic emissions are still a concern, actually total benzene emissions into the atmosphere have been going down each year for the last several years.

The CHAIRMAN. Ms. Stuntz, do we have a sufficient supply of natural gas in North America to switch our mass transit systems and urban fleets and vehicles to compressed natural gas?

Ms. STUNTZ. Sir, I believe that over a reasonable transition period, we do. Our natural gas resource base has been estimated by the department to contain well, more than 35 years of current supply at $3 less. And substantially more than that, if the price rises higher.

Now, you would not want to do that overnight but you could not do that anyway. I do not have exactly at my fingertips the total amount of natural gas that would be required to convert all of those facilities. But I think that the resource base is ample. Particularly if you consider Canada as part of that resource base which we think is appropriate, given the Free Trade Agreement and other measures.

We would be happy to respond for the record on specific numbers and over what kind of transition period we think that could be accomplished.

[The information follows:]

Urban transit buses account for less than 40,000 B/D of oil use nationwide. Substituting natural gas for this will increase gas demand by less than .1 TCF or about 1/2 of 1% of current annual use. This could be readily accommodated from present U.S. gas supplies.

The question of "urban fleets" is more difficult to answer, in part, because the definition of "fleet" vehicles is imprecise. Our data indicate that there are about 10 million automobiles in "fleets" of 4 or more vehicles. About 3 million of these are in daily rental or are individually leased, and may not be readily adaptable to CNG use. We estimate that the remaining 7 million vehicles (which are used by business, government, utilities, police and taxi companies) use about .5 MMB/D of oil.

Replacing this oil use with gas would require an additional 1 TCF annually or about a 6% increase in current use. This amount could be easily accommodated from U.S. gas supplies. But, there could be some difficulty in meeting the additional demand in some locations during periods of high gas demand, such as the winter heating season. Also, it would require some time and investment to install sufficient facilities to supply the gas to motor vehicles.

The CHAIRMAN. Yes. I wish you would. That also seems to me to be sort of a natural. I mean for fleet use compressed natural gas would seem to just work very well, not difficult technology, a tremendous pay-off.

It would seem to me that they ought to be able to learn to mass produce and redesign tanks, which would be not quite as heavy or bulky and a lot cheaper to produce.

But do you have any advice on bringing down the cost?

Ms. STUNTZ. There has been some real movement just over the past year, particularly, on buses and heavy-duty vehicles. Where people are looking at different placement of the tanks, different materials to construct the tanks that would allow the gas to be maintained at an appropriate pressure with less weight.

We have two buses in Columbus, Ohio that we did not have a year ago that really were designed as CNG vehicles not converted or retrofitted. And I think it is through experience with those kinds of vehicles that we can move, I think, smartly ahead in the types of uses that you are talking about.

The CHAIRMAN. Would not that give, Mr. Wilson, a tremendous pay-off for Los Angeles and other areas that have particular problems? Compressed natural gas?

Ms. STUNTZ. One thing I might suggest, sir, is you do have to look beyond the resource phase and your mention of Los Angeles reminded me.

We do have problems in terms of getting it to some of the nine cities. For example, I think if you look at, as I believe is correct, right now California—Southern California has got some curtailment in effect for natural gas usage because of transmission facilities and bottlenecks unfortunately in the distribution system that exist.

That would need to be taken into account in looking at how quickly you could convert these, not just is it in the ground, but can we get it to where it needs to go, over what period of time.

The CHAIRMAN. Well, can we in Los Angeles, particularly?

Ms. STUNTZ. We cannot right now.

The CHAIRMAN. How long will it take?

Ms. STUNTZ. That is a very good question. They have been—we have been trying to get some new pipeline capacity into California for, I think, about seven years. And we are close now, but no ground has been broken yet.

And whether it comes from Canada, or whether it comes from Mr. Bingaman's country, I hope we can get that done soon. But there definitely is a problem right now getting gas to California and getting it moved around in California.

The CHAIRMAN. By the way, compressed natural gas is a lot less dangerous than liquefied petroleum gas, is it not? To deal with?

Ms. STUNTZ. I think it has different qualities. It kind of depends on which of those features you are talking about.

The CHAIRMAN. It goes up in the air.

Ms. STUNTZ. It does not pool on the ground in the same way. It dissipates more quickly.

The CHAIRMAN. The danger of it is not a tremendous consideration. Is it?

Ms. STUNTZ. I do not believe so.

Mr. WILSON. Sir, we think all these fuels can be used safely. They all have different properties that you need to deal with. But they can all be used safely.

The CHAIRMAN. Senator Ford.

Senator FORD. Thank you, Mr. Chairman.

Ms. Stuntz, when you stated that corn was a primary source of manufacturing of ethanol today, and that is not a stable price. Farmers want more for their money, but they would like to have a steady sale of corn.

And we found that where corn prices are higher than what can be sold, as it relates to, I guess, ethanol in the gasoline. We find that there is a lot of corn in storage. In fact, on barges on the river, and let it rot and go away. But we cannot find any help from the Federal Government as it relates to securing that corn.

Some of them have brown—I do not know whether you are familiar with corn or not, but it has black grains in it and it does not sell very well. But that can be used for making ethanol almost like the good corn, or in fact just as well.

Any thought given to help some of these ethanol plants that are having extreme troubles staying afloat to use that corn? We have tried everything I know to try and might get some punch from people like you. We have a plant at home that just absolutely had to close down.

Ms. STUNTZ. Sir, the Department of Energy is now the owner of a ethanol plant in Mr. Johnston's neighborhood.

Senator FORD. I know but we have got one in Kentucky in our neighborhood we would like for you to buy too. [Laughter.] And maybe some day I will get to be chairman of the committee and you will buy mine. [Laughter.]

Ms. STUNTZ. We are working with Secretary Yeutter. As the chairman alluded to earlier, Secretary Yeutter and the Department of Agriculture have taken a little different view right now than in the past.

Secretary Yeutter has had a meeting with Secretary Watkins, which I was able to attend, where this was discussed, in terms of how we as departments could work together to improve the potential, not only in the future to expand this resource base, but what do we do about the infrastructure we have now.

I do not have any quick answers. I think a key will be, as I understand it, some of these corn supplies, and I did grow up on a farm, some of these corn supplies are getting worked off, some of the reserves are a little less than they were before. The price of corn is up some this year.

You are right, ethanol is very sensitive to the price of corn. It is good for farmers when the price goes up, but the promise is not so good for the ethanol industry, because that puts it further above the price of competitive fuels.

I think one of the best answers will be through alternative fuels programs to try to get the market established, which is what the President sought to do in the Clean Air Bill.

Senator FORD. Well, he cannot establish a market for corn, as it relates to ethanol, as a wage and price control, or something like that.

Now, tell me about wood and waste ethanol. You mentioned that. But that would be post-2000 before we get to it. We will have all of the stationary emitters worked out by that time, also, or we are supposed to.

Ms. STUNTZ. Well, there are some in the department who think that we can do it now. The technology is there. But, again, it is a matter of cost. We cannot do it right now for even what it cost to produce it from grain. That is why people in the private sector are not doing it.

But we think there are some exciting new technologies out there, membrane technologies, that could take the cellulose from trees and herbaceous, and woody stalks and plants and things that do not have value as grains, and use them, so you would have a much lower-cost product coming out at the other end.

Senator FORD. Is it Brazil that uses sugar cane?

Ms. STUNTZ. They do.

Senator FORD. Is that primarily their source for ethanol?

Ms. STUNTZ. Yes, sir.

Senator FORD. What would they pay for a gallon, in American money, of ethanol for their cars? And maybe Mr. Wilson would know.

Ms. STUNTZ. I would like to supply that for the record if I could. I do not want to guess wrong.

[The information follows:]

The current retail price of ethanol in Brazil is about $1.30 per gallon as compared to gasoline at $1.90 per gallon (at current exchange rates). This means that the two fuels are selling at about the same price per BTU of energy content. These prices, however, do not reflect the cost of producing and retailing ethanol because there are a variety of tax incentives and subsidies provided to ethanol producers and consumers in Brazil.

Senator **Ford**. All right.

Now, you perked my interest a little bit. You said electric cars' emissions depends on how the energy is generated for the supply source.

Well, here I am, down here driving a little electric car, and it has got a battery in it. And I did not see any exhaust, unless it was maybe I was driving it so darn fast the oil got hot and we had a few fumes. Whether it is generated with coal or natural gas or oil, I do not understand how that battery is going to emit exhaust.

Ms. **Stuntz**. No, sir, the operation of the car does not have any emissions. For the generation of electric vehicles we now have, you cannot just sort of put in a battery and run on that forever. You have to recharge it.

Senator **Ford**. I understand.

Ms. **Stuntz**. You have to plug it in.

Senator **Ford**. Right.

Ms. **Stuntz**. And what you get when you plug it in, whatever provides that juice is going to have emissions if it comes from a power plant. That is what I was talking about.

Senator **Ford**. Back at the base?

Ms. **Stuntz**. That is right.

Senator **Ford**. Well, why do we not just have solar and we will not have to have any?

We talked about natural gas and plenty of it, a 35-year supply. Let me read you something I read, at the last one. A spokesman for the Natural Gas Supply Association of America said that its major producer members favor the use of CNG in fleet vehicles, but have not taken a stand on other motor vehicle clean air issues.

He said that INGAA does oppose widespread use of methanol for cars because, and I quote, "that would require importing a lot of methanol because we do not have the excess natural gas production to make methanol."

Now, do you agree with that?

Ms. **Stuntz**. I think that I do.

Senator **Ford**. You think that you do?

Ms. **Stuntz**. Well, if I understand what the spokesman is saying, I did not issue the statement, but when I answered Senator Johnston's question, he had asked me about fleet usage, and I do believe that my answer that we had adequate supplies of natural gas for fleet usage is consistent with that gentleman's answer for fleet usage.

When you talk about methanol, it is a little more complicated, perhaps, than that statement said. You are talking about going beyond fleet usage, and do we have natural gas to convert every car in this country to CNG? And I would say we do not.

I would also say that we do not have sufficient supplies of low-cost natural gas to make methanol from that are at a price competitive with imported methanol.

Senator **Ford**. Another statement was that you would have widespread use of methanol; maybe that does not mean every car.

I think the bubble is getting ready to go on natural gas one of these days, and the problem is that if you have natural gas, you have to be able to distribute it. And we have got a place called

FERC that you just cannot get through. It is like going to heaven, you have got to stop in Atlanta.

But you have got a lot of applications for new pipelines and so forth, and we are just not getting them through.

I will not take much more time, Mr. Chairman, but, Mr. Wilson, you said that urban buses must run on alternate fuels for 1991. That is a lot of buses.

Mr. WILSON. Sir, the proposal talks only about the new purchases. So, beginning in 1991, 10 percent of the new buses purchased for cities would have to run on alternative fuels, and then the number jumps to 100 percent, it sort of phases up, by 1994, when all the new purchases would have to be alternative fuels.

So, it would take several years for all the bus fleets to change over.

Senator FORD. Well, 100 percent by 1994?

Mr. WILSON. 100 percent by 1994 of the new purchases, yes, sir.

Senator FORD. I am just driving around and talking to people and listening. And every once in a while you stop and get some gasoline for your car, and they are worried about evaporation fumes coming out of the tank, and they have got to have covers on it. And the companies are selling their stations.

They do not want to have anything more to do with them, and they want the little guy that has been running it to buy it. And most stations are running $350,000 to $450,000, and then they have to put in new tanks and dig the dirt out, and figure out where to put the dirt. And you have got a new type of tank to stop evaporation.

And it is almost getting to the point where it is impossible for a little guy to run a service station anymore. The big guys are selling out and they do not want to have anything to do with them.

What do I tell this service station that has been starting Mrs. Ford's car in the rain and snow and slush all the time, and all of a sudden he has got to buy it? And the insurance he has got to pay for it, one of them told me it is just almost prohibitive, and you cannot get an SBA loan because they do not think it is worth it.

What is that guy going to do? Are we just going to close them down because we have got so much on their shoulders? Or are we going to be able to phase it out, phase it in, or something?

It is more than one aspect; we are talking about alternative fuels, but it goes back to the company and the guy that puts it into your tank, and those of us who buy it.

Mr. WILSON. You are correct, Senator. There are a series of issues that I think are placing a significant burden on the local gas station owner. I think we do need to phase them in to make sure that we are not putting all these people out of business.

Some of the things we are talking about can help in that regard. You mentioned the control so that the fumes that come out of the tank when you are refilling your vehicles are captured.

Senator FORD. Is the car manufacturer going to do that? Is it going to be imposed upon the service station owners?

Mr. WILSON. Well, one of the advantages of some of the alternative fuels we have been talking about is they are not as volatile. And so that property of gasoline, the volatility that creates those additional fumes, would not be there for others.

Senator FORD. Yes, but they are going to have to put these things in place before you get that done.

Mr. WILSON. Well, yes, sir, that is true, but in the long term, I am saying some of these can in fact help, and not just add more to the pile of requirements on this.

Senator FORD. Well, I just find that the word is to go, and when you want to go, you sometimes make a lot of mistakes. And I am not opposed to cleaning up the atmosphere, I think we ought to, and I think we ought to do it just as fast as we can.

But I sit around here, and I have been here 15 years, and we have talked about alternative fuels ever since I have been here. We have talked about synthetic natural gas and we have talked about the liquefaction of coal and all these things where you take the impurities out of it.

And we had a little nest egg to move, about $18 billion, you know, and it seems something happened in 1980 and 1981 and that was all taken away, and now the marketplace has got to do it.

And then you are telling manufacturers, he has to have 30 percent of the cars sold in certain places by certain times, so that means that you are putting it back on into the marketplace and it ultimately comes back on the consumer.

And I do not find very much help, except imposition and new rules that have to be carried out by the manufacturer, and ultimately paid by the person who drives up to the service station. When you get all done, that is basically the plays.

And I find, even when you pump it yourself around this town, it is a $1.10 or $1.15 a gallon, and that is the cheapest.

So, I just wonder how much further we are going. As I say, I am not opposed to it, but I do not find much help from government out there; I find a lot of imposition and new responsibilities on them.

Is that the way it is going to be?

Mr. WILSON. Well, I hope not, Senator. I hope there is some extra help that comes along with it.

Senator FORD. What is extra help, Mr. Wilson?

Mr. WILSON. Well, as I say, I think we need to phase these programs in so we give people time to develop the technology and time to deal with the economics.

Senator FORD. I do not find any time up here, I see a lot of folks rushing, they would like to get the Clean Air Bill passed this week, and all of this would be imposed. And that is not phasing in. I do not see anything in there phasing it in.

Mr. WILSON. Well, we would like to see the Clean Air Act passed quickly, but that does not mean all the programs that are contained in the bill need to become effective quickly. As we talked about the bus program, we would phase it in over a number of years. And I think all these programs need to be looked at in that respect.

Senator FORD. Well, we are going to pass the bill and just let you do whatever you want to do, is that it?

Mr. WILSON. The various bills I have seen being considered tend to be fairly restrictive on what they want us to do.

Senator FORD. God, I hope so.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Ford.

Senator Nickles.

Senator NICKLES. Mr. Chairman, thank you. And I appreciate Senator Ford's line of questioning.

This hearing is not on the underground tank proposal, but, Mr. Wilson, myself and many other senators had contacted the EPA asking for a little leniency or a little time so those gas station owner/operators, primarily the small ones throughout the country, would have a little time to comply. Because they could not purchase insurance or they did not have some type of a state pooling mechanism to purchase that amount of liability insurance.

And frankly, the EPA, if I am correct, or informed by staff, they did not extend the time. I think the deadline was October 26th, is that correct?

Mr. WILSON. Senator, I am not sure about that. I would be happy to get that information for you and supply it for the record.

Senator NICKLES. I believe it is. And again, I appreciate Senator Ford bringing that up, because we have a lot of places and a lot of small communities, in small and rural parts of the country, there may be only one gas station owner/operator. And they may not be able to get the liability or the bond requirement. And therefore they are shutting down.

And for those communities, that can be very detrimental to them. So I make the point to supplement what Senator Ford had said.

Mr. Wilson or Ms. Stuntz, either of you, both of you mentioned repeatedly, and I knocked the fuel neutrality segment in my opening statement, I read your statements, both of them said that they were fuel neutral.

Let me ask you a couple of questions. You say they are fuel neutral, but you mandate that the automobile manufacturers have to produce, distribute. It says they would be required to produce and distribute by the year 1997, a million automobiles per year for the next, what, seven years. So, by the year 2004, you are going to have seven million-plus, you phase it in a little bit, so eight million automobiles on alternate fuels.

You mention several alternate fuel proposals. You mention some that this Senator—you know, a lot of people are already burning propane or butane, and that is all across the country. It seems to me to make sense. I mentioned compressed natural gas. Senator Johnston asked would there be enough to do it in the large cities with those two fuels.

Can we meet the standards with those fuels?

Mr. WILSON. Absolutely.

Senator NICKLES. Is there enough of those fuels to supply eight or 10 million automobiles by the year 2004?

Ms. STUNTZ. Yes, sir.

Senator NICKLES. And what about reformulated gasoline?

Ms. STUNTZ. I think supplies of that are ample in whatever form that that would take.

Senator NICKLES. I understand.

Would reformulated gasoline meet the standard of 80 to 90 percent reductions by the year 2000?

Mr. WILSON. We are reasonably sure it could meet the 30 to 40 percent reduction required in the first stage.

Senator Nickles. I am aware of that.

Mr. Wilson. I think it is too early to tell whether it could meet the 80 to 90 percent reductions in the second stage. Although in the President's bill there is a program where you can take credit for having sold that gasoline to more of the vehicles, and therefore, if you sell more than the 30 percent required, you can get credit for that.

So, even the long-range targets for reformulated gasoline would be less than the 90 percent.

Senator Nickles. Let me ask you a question. If we are talking about propane or butane or compressed natural gas, you mentioned all of those could meet the standard, and I still think you are advocating methanol, and that can meet the standard, as well. Am I correct, methanol can meet the standard?

Mr. Wilson. Yes.

Senator Nickles. It can meet the 80 to 90 percent standard by the year 2000?

Mr. Wilson. You are correct, it can meet it. You are not correct that we are advocating it.

Senator Nickles. I think you are, still. I am working my way around there.

What is the cost of methanol—how much more would a methanol car cost?

Mr. Wilson. Well, the estimates we have from the auto industry are that a methanol car or, an ethanol car, frankly, that was designed to run on both methanol or ethanol or gasoline, would cost in the range of $150 to $300 more per vehicle at the kind of production volumes we are talking about under the President's proposal.

Senator Nickles. So it would be dual fuel? They could go from gasoline——

Mr. Wilson. The dual-fuel vehicle would be a little more expensive because it has to be able to operate on either, and need sensors to know exactly what fuel combination is in the tank.

If and when you get to a vehicle designed specifically for that fuel, then we think the cost would probably be roughly the same as existing vehicles. There are some things you would have to do differently that would save money, other things that would cost a little more. We think, on balance, it would about net out, so the vehicles would——

Senator Nickles. Mr. Wilson, I may be wrong, but my guess is that most Americans like to drive their vehicles in all kinds of directions.

Mr. Wilson. Of course.

Senator Nickles. And so they might not have that—they will want a dual-fuel vehicle. I do not see how you can get away from that, except for maybe certain fleet operations, where it might be pretty restricted, company-owned, or something like that.

Mr. Wilson. Well, that is certainly true. And until the program or the fuel developed enough that it made sense to have it available on more of a nationwide basis, obviously, people would not be interested in buying vehicles that they could not take.

Senator Nickles. That is right. Therefore, you are going to need a dual-fuel vehicle. So how much extra would that cost?

Mr. **Wilson**. Well, as I said, the dual-fuel vehicles are roughly $150 to $300, which is the industry estimate.

Senator **Nickles**. So they could burn on methanol or ethanol or gasoline?

Mr. **Wilson**. Or gasoline.

Senator **Nickles**. Reformulated gasoline.

Mr. **Wilson**. Yes.

Senator **Nickles**. And those are only going to cost $300 more by the year 1997?

Mr. **Wilson**. Yes, that is right.

Senator **Nickles**. Do you want to bet?

Mr. **Wilson**. Well, as I said, we agree with those estimates, but they are the auto company estimates, not ours. And yes, if you go through, surprisingly, there are only 30 or so parts that need to be changed. They are basically a gasoline car, but with a few different parts.

Senator **Nickles**. Well, let me ask you a question. If it is only $150 or $300, and if you are talking about methanol—but methanol, it takes twice the volume to go the same distance, am I correct?

Mr. **Wilson**. Well, not quite twice, but it does take more gallons to go the same distance than with gasoline. It has a lower BTU content.

Senator **Nickles**. And you have somewhat the same problem, I guess, with butane, is that correct or not?

Mr. **Wilson**. Yes.

Senator **Nickles**. What kind of distance can you get on a tank of butane? Is it half or something like that?

Mr. **Wilson**. Mr. Gray?

Mr. **Gray**. Butane has about two-thirds the energy per gallon equivalent to gasoline, so you would need——

Senator **Nickles**. So if you get 300 miles on a tank full of gas, you would only get 200 miles on a tank full of butane—the same volume?

Mr. **Wilson**. The same volume of tank, yes.

Senator **Nickles**. The same volume of tank.

Mr. **Wilson**. You may want to increase the tank size on some of these.

Senator **Nickles**. And compressed natural gas, you would have to have a much larger tank?

Mr. **Gray**. Compressed natural gas is a different type tank because it is stored under higher pressure, and it is larger, as well, that is correct.

Senator **Nickles**. So, if you use the same volume as, say, gasoline for compressed natural gas, you would only have—if you had 300 miles on a gasoline tank, you would have what, 150 or 100?

Mr. **Gray**. You would not use the same volume because you would have even less than that with compressed natural gas.

Senator **Nickles**. You would have to fill up about every 80 miles?

Mr. **Gray**. Well, the industry just would not sell that kind of a vehicle, because the public would not accept a car of that type. So you would have a larger tank.

I mean that is where all the focus is, how do you make a cost-effective design that would have enough space for the tankage. Because the consumer just demands a certain minimum range, and that is nominally 250 miles at least, and 300 miles for common use.

So a vehicle manufacturer would have to phase in vehicles that have accommodated the space requirement for the fuel. Gasoline just has a very high energy density, and all the other alternatives would have to have more space for the fuel storage. But that is just an engineering question.

Senator NICKLES. I understand. Again, I make my premise, Mr. Chairman, that—you see, I kind of think that butane and propane, they make sense. As a matter of fact, of the LPG vehicles, what, we have something like 300,000 running in the United States today, and worldwide, several million, is that correct?

Mr. WILSON. Probably.

Senator FORD. How many farm vehicles, farm tractors?

Mr. GRAY. There is no technical question associated with LPG. The principal concern, as was testified, is the availability. LPG is obtained from two sources. It is stripped from natural gas production, natural gas liquids, and it is also a petroleum refining process product.

And the availability of that material for transportation is significant, but not sufficient to displace gasoline by any stretch of the imagination.

Senator NICKLES. But it is sufficient to supply all of these millions of automobiles that you are going to mandate, or at least you expect that it would be?

Mr. WILSON. Senator, we expect that there are going to be several of these fuels used in response to the program we have talked about, not just one.

I think a lot of the debate makes it sound like compressed natural gas is competing with methanol, it is competing with LPG, it is competing with electric. And, in fact, each of those is going to be competing and it is going to be successful in areas where it has the most advantages.

I think compressed natural gas and propane are most likely to see initial use in fleet vehicles, where range is not so critical an issue, where refueling facilities can be centrally located and not require the same distribution.

So we think all these fuels are going to be used in response to the program. And frankly, I think it is a bit unfortunate that we sometimes spend more time debating among the alterative fuels than comparing their beneficial characteristics to existing gasoline.

Senator NICKLES. I hope your program is truly as fuel-neutral as you have stated and as Governor Sununu has stated to me and I have debated with him in the past. But, still, when I look at the final standards, I think those standards are going to be very expensive. I think you are optimistic if you think it is only going to cost consumers $150 or $300 per automobile.

I also am concerned when you mandate this million vehicles per year. I thought this administration was more market-oriented and would maybe encourage development of alternative fuels. But to mandate the sales, when there may or may not be a buyer, seems absurd.

And I do not know, they may be cheaper, because it may be that nobody will want to buy them, and the manufacturer may have to give them away or give them such discounts or incentives for those automobiles to be purchased. I do not know.

But any time I read that automobile manufacturers would be required to produce, that is troubling at least to this Senator. I would like to have it be a little more encouraged and not quite so dictatorial, because we may not have quite the wisdom.

I agree with your statement, I think reformulated gasolines might be able to do part of this 30 or 40 percent; I doubt that they can do the 80 to 90 percent. I do not think that will happen by the year 2000.

Now, I may be surprised, and I hope I am surprised. But I think the net result is that you are putting on some pretty strong dictates or mandates.

Let me move on to one final comment, and that is concerning the pollution problem. The objective is to clean up the air and to make the cities more environmentally acceptable. I agree with that. I happen to be a jogger. I happen to jog around this Washington, DC area and get behind some of these nasty old buses that just blow your mind away.

What is in the program to really do something about some of the older buses, trucks and vehicles that are really the real significant causes of pollution today?

Mr. WILSON. Well, one of the things we are doing is reformulating diesel fuel along with gasoline, which, under the bill, would remove sulfur from the fuel, making the particular emission smoke less than it is now.

Unfortunately, while better maintenance can help with those existing vehicles, and certainly some of them can be converted to alternative fuels as well, it really is easiest to deal with the emissions with the new vehicles.

As I mentioned, our proposal had the requirement that new buses be run on clean, alternative fuels starting in 1991.

Senator NICKLES. I understand the new vehicles, but I do not think the new vehicles are the significant and serious problem. I think the significant problems, and maybe I am wrong, but again, I have seen and we have all seen a lot of vehicles, the heavy construction-type vehicles, or something.

Mr. WILSON. There are programs, as I mentioned, the cleaner fuels and better maintenance. But there are programs that have been underway that are supported by the Urban Mass Transit Administration, to convert existing buses either to compressed natural gas or methanol, two examples of clean, alternative fuels.

Senator NICKLES. What emission standards for those older vehicles that, if they pollute beyond a certain amount, they would not be licensed or they could not get a vehicle inspection?

I mean right now if you buy a newer car and your catalytic converter does not work, you cannot get an inspection sticker. I believe I am correct.

Mr. WILSON. That is correct.

Senator NICKLES. What about applying some of that, maybe not on the catalytic converter, but for some of the older machinery and/or equipment, or something like that, the real gross violators, the real polluters, what about putting some type of requirement on those?

Mr. WILSON. I agree with you, Senator, and that is one of the things we are looking at.

It is particularly difficult for us. Obviously, it is important to try and get people in major cities to use the public transportation more and their own autos less, and it is difficult to convince people that it is good for clean air for them to leave their relatively clean-looking car—you know, car exhaust—at home and get on one of the buses that is putting out lots of black smoke.

Senator NICKLES. When you get on the buses and you think how I am helping the problem, and you see all this black smoke coming out, you do not really get the feeling that you are contributing to the solution.

Mr. WILSON. Right.

Senator NICKLES. And so I would encourage you to look at some of the older vehicles, and maybe look at the standards. And I think some real progress could be made there.

Part of my point is that you are going for incremental increases on newer vehicles that is going to drive the cost of those vehicles up. And if you drive it up too much, you are going to make those costs of vehicles out of reach, and people will not be able to buy the new vehicles, so they continue to drive their old, polluting automobiles and ones that have less fuel efficiency.

And the same argument on CAFE. You can be very utopian in your goals, but you may price it out of reach, and therefore you are going to continue the utilization of the real polluters and the real gas hogs. And that is not your objective.

Thank you, Mr. Chairman.

The CHAIRMAN. Senator Bingaman.

Senator BINGAMAN. Thank you, Mr. Chairman.

I want to thank Mr. Wilson for the help that he has provided to us in Albuquerque in dealing with our pollution problems. We appreciate it very much, and we will continue to call on him.

I would like to ask either of the witnesses to comment on what they see as the need at this stage for additional federally supported research into appropriate alternative fuels and such related matters as fuel cell research and those types of things.

Are we to a stage in this process where industry can do the research that needs to be done? Or is there still a need for a degree of federal support for research?

Ms. STUNTZ. Senator, at the department, we are placing primary emphasis on developing alcohol fuels from what would now be viewed as non-conventional sources, including coal as I discussed with Senator Ford, and from woody plants of a kind that are not now used, in order to bring down the cost.

We are also devoting a significant amount of effort to electric vehicles, to improve the batteries, to improve and bring down the cost of those vehicles, because they still have a very high cost.

We are placing less emphasis on CNG and propane, because that technology seems to be fairly well developed worldwide, although we think that the kind of emphasis on alternative fuels that the President's proposal has created is generating some new interest in trying to solve these problems with tanks that you have heard discussed today.

Senator BINGAMAN. I guess what I am trying to get at is that my impression is that we are doing very little in the way of federal support for research related to this subject matter. Whether it is fuel cell research, whether it is whatever, that we really are not making a major effort. And I just wonder if that is wrong.

If it is correct, should we be doing more? What is your view on that?

Ms. STUNTZ. Just to follow up briefly. The Department of Energy is spending, I believe, this fiscal year, $18 million on electric vehicles alone. The additional work that we are doing on methanol from coal, I do not have that number on the top of my head, but I imagine it is comparable to that when we take into account the work that is being done by our regional offices.

And that is just sort of on our side of the plate.

I will defer to Mr. Wilson on his side.

Senator BINGAMAN. Did you have a comment for EPA?

Mr. WILSON. No. Except, as Ms. Stuntz said, we think the interest now on alternative fuels and the fact that we may well be creating a marketplace where they can break into the oil monopoly, I think it is going to spur research not only at the federal level, but in private industry as well. Because they now know there is something they can do once they get that development under way.

And I think we have got some of the technology now that is ready for industry to produce. I think we need to look a generation away as to what the next round of technology is likely to be, and we need to be doing research in that regard.

Senator BINGAMAN. Can we expect that in the President's budget that we get early this next year it will reflect an increased emphasis on this type of use of alternative fuels and some of the technical problems associated with that?

Ms. STUNTZ. We are certainly working toward that objective, not only because of the energy security responsibilities that we have, but reasons of environment, whether it is ozone and the matters we are talking about today, or whether it is global climate change. Because some of these alternative fuels do have significantly reduced CO_2 potential, and that is important to us.

Senator BINGAMAN. Let me ask, I think you made some comments alluding to this, but I have a bill that I introduced which proposed a conversion of a percentage of the federal fleet, increasing the percentage each year. And I know that is part of what your recommendation is, too.

How do you see the importance of converting the federal fleet over to the use of alternative fuels as part of it? How does it fit into the strategy? How significant is it?

Ms. STUNTZ. Senator, if I could defer to Dr. DiFiglio to my right, who is the executive staff director of the Alternative Motor Fuels Commission that has been established by the act of 1988 and who I know has been working on this.

Dr. DIFIGLIO. Yes. The Interagency Commission for Alternative Motor Fuels has engaged in an inventory of alternative fuel fleet programs, and is undertaking a comprehensive assessment of the ability for alternative fuels to enhance our energy security under the direction of Mr. Henson Moore, Deputy Secretary of Energy.

Senator BINGAMAN. Well, I guess my question is, to what extent do you think the Federal Government's conversion of its fleet over to the use of alternative fuels is an essential part of dealing with this?

Dr. DIFIGLIO. Well, under the Alternative Motor Fuels Act of 1988, which establishes the Interagency Commission for Alternative Motor Fuels, we have an authorization of $12 million to implement a federal demonstration program of alternative fuels in light-duty vehicles, and authorization of $6 million to develop heavy-duty vehicles.

So, one of the main goals of the Interagency Commission is to carry out the implementation of a federal demonstration of both light- and heavy-duty vehicles. And this demonstration of light-duty and heavy-duty technology will help implement the Clean Fuel Program by providing data and information.

We are also looking to several private fleets, which are available. And the Interagency Commission is attempting to establish a data protocol so that these private fleets can be worked into our program.

The Alternative Motor Fuels Act of 1988 requires the Interagency Commission to provide several specific reports on particular topics and annual reports on the overall program. And in these reports we expect to provide the kind of information that the EPA administrator will be able to use to implement the President's Clean Fuels Program.

Senator BINGAMAN. Mr. Wilson?

Mr. WILSON. Senator, I would just mention that I think clearly the Federal Government needs to be in a leadership role here, in terms of its fleet vehicles, and in fact, has been. The Department of Defense has operated a number of its fleet vehicles with methanol technology, the post office has used a number of compressed natural gas and I believe electric vehicles as well.

So, I think a number of the agencies with significant size fleets are already well along to developing alternative fuel technology.

Senator BINGAMAN. I guess I am a little concerned about the timetable on this federal demonstration project that you referred to. Your mandate, as you see it now, is to implement the establishment of a federal demonstration project, is that what you said?

Dr. DIFIGLIO. Yes, sir. We expect that we will be able to purchase vehicles from the manufacturers as early as model year 1993. We realize, of course, that——

Senator BINGAMAN. How many vehicles would you estimate?

Dr. DIFIGLIO. We have not been able to put a figure on that yet, because it depends on the cost of the vehicles. But we are also looking to take advantage of several private programs. We are looking towards Federal Express and other mail distribution companies which are very interested in testing alternative fuel vehicles in particular areas like Los Angeles.

And one of the members of the U.S. Alternative Fuels Council, Congressman Alexander, has expressed very strong interest. The department intends to support these programs, and by establishing a data protocol, be able to take advantage of the information provided by these many private demonstrations.

So, we see a combination of the private and federal efforts steadily developing a new database that the Administrator can use to test the performance, the cost, and the practicality of using these alternative fuels.

Senator BINGAMAN. Ms. Stuntz, you said here in the second to last paragraph of your testimony that you are moving rapidly to establish a common database with which to evaluate the performance and emission characteristics of these vehicles.

What does that mean, "moving rapidly"? When will this be done? When will this protocol that was just referred to be issued?

Dr. DIFIGLIO. Well, we expect to establish a set of standards before the end of the fiscal year 1990.

Senator BINGAMAN. Thank you very much.

Thank you, Mr. Chairman.

The CHAIRMAN. Thank you.

Senator Murkowski.

Senator MURKOWSKI. I have no questions, Mr. Chairman.

The CHAIRMAN. Ladies and gentlemen, thank you very much for your testimony; we appreciate it.

We will have some questions in writing.

Next, we have a panel with Mr. Joseph M. Colucci, Department Head, General Motors Research Lab, General Motors Technical Center; and Mr. William S. Dickinson, Manager of Engineering and Technology of Arco Products Company from California.

And I might mention that we are getting a little bit behind time. We have another seven witness, these two included, so if you gentlemen can summarize, and if the senators will try to be a little more brief, then I think we can give everyone a chance to make their say.

Mr. Colucci.

STATEMENT OF JOSEPH COLUCCI, DEPARTMENT HEAD, FUELS AND LUBRICANTS, GENERAL MOTORS RESEARCH LABORATORIES

Mr. COLUCCI. Good morning. I am Joe Colucci, Department Head, Fuels and Lubricants at the General Motors Research Laboratories. I am also co-chairman, with Dr. Keith McHenry of Amoco, of the joint Auto-Oil Programs Research and Planning Task Force.

GM recognizes the potential of alternative fuels to promote energy security and environmental objectives. We also realize that the task of implementing a workable alternative fuels programs is extremely complex.

Successful introduction of any alternative fuel for national demands will depend not just on the availability of technology, but also on the resolution of an array of other factors, including economics, supply and distribution considerations, safety, and most importantly, consumer acceptance.

Each of the major fuel alternatives for current gasoline has unique characteristics with respect to these factors, as well as to their environmental and health-related impacts.

For these reasons, GM is exploring a variety of fuel options targeted to different types of applications and customer requirements.

Today I will focus on our efforts in three areas: reformulated gasoline, methanol and natural gas.

GM's interest in reformulated gasoline is based on a growing awareness that an effective transition is the key component of any alternative fuels program. Reformulated gasoline is of special interest as an alternative to current gasolines because it could be used in existing vehicles. This would provide great leverage in improving air quality without demanding any changes in the behavior or expectations of consumers.

On October 17, GM, together with Ford and Chrysler and 14 major oil companies, announced a comprehensive joint research and testing program to evaluate fuels for use in current and future model cars and light-duty trucks. The program will support President Bush's Clean Air Act proposals, which, for the first time, considers both cars and trucks and the fuels they use.

In the initial phase of the program now underway, we will seek to determine the emissions, air quality effects, and cost/benefit relationships of various methanol fuels used in prototype vehicles and of reformulated gasolines used in current as well as past model vehicles.

During this phase of the program, all types of vehicles' emissions, exhaust, evaporatives, and running losses, will be measured to determine the potential reductions in urban ozone from use of any of the fuels tested.

In the next phase, projected to start next year, we will use information from the initial stage to conduct research on advanced technology alternative fuel and gasoline-powered vehicles. Other alternative fuels, such as compressed natural gas and neat alcohols, will also be considered.

Until now, our work at GM has focused on the alcohols, methanol and ethanol, which we have approached in several ways. Currently, all of GM's gasoline vehicles are designed to use alcohols as oxygenated components in gasoline.

Gasoline containing oxygenates can act to make the engine's air-to-fuel ratio leaner, and this can result in less carbon monoxide emissions.

Beginning in the current model year, we are recommending in our owner's manuals the use of properly blended gasolines containing oxygenated components.

We are also looking at the other end of the spectrum, high-alcohol content fuels. Here we are concentrating on M-85, which is 85 percent methanol and 15 percent gasoline, and its use in variable-fuel vehicles designed to operate on any combination of fuels, from pure gasoline to these high alcohol concentration blends.

The variable-fuel vehicle represents a necessary step in the transition to alcohol fuels because of the current absence of an alcohol-fueling infrastructure. Until such an infrastructure is fully operational, consumers would be hesitant to invest in vehicles that depend on non-traditional fuels with limited availability.

Realistically, assuming alcohol fuels can be economically competitive with gasoline, we think the transition to dedicated vehicles would take at least 10 to 15 years, and even this timetable would require an aggressive program with a national commitment.

We are now involved with a number of pilot programs to help us understand the issues associated with introducing methanol-fueled vehicles on a commercial basis. We are especially pleased to be participating in the California Energy Commission's methanol fuel-flexible vehicle demonstration program, currently the largest yet announced variable-fuel fleet program in the United States.

Between now and 1992, GM will supply 2,220 vehicles, as well as special service training and support to the project. These vehicles will be equipped with GM's newly developed variable-fuel control system.

Another potential alternative fuel is natural gas. We believe there is demonstrated potential for the use of dedicated natural gas vehicles in central fleet applications, and GM is pursuing these opportunities.

Although we are making major progress, considerable uncertainties remain about how alternative fuels programs will fare. Numerous questions about materials, durability, range, refueling, safety, and operating conditions still must be resolved satisfactorily.

Much is yet to be discovered about issues such as anticipated air quality benefits, health effects, toxicity, and the impacts of such fuels on global climate change.

But the greatest gap in our knowledge base is the consumer. We know very little about how U.S. consumers will respond to alternative fuels and the vehicles that use them. Nor do we know the best ways to win consumer acceptance of alternative fuels programs.

For these reasons, we have serious reservations about any program that mandates the sale of alternative fuels vehicles.

GM supports Senate bill 1490's clean fuel objectives as an innovative approach to promote clean air. However, we do not believe auto manufacturers should be required to guarantee specific sales volumes. Instead, our responsibility should be to provide adequate production capacity to offer vehicles for sale in the required numbers.

In that form, the clean fuels program would still represent an extremely aggressive program that will stretch our resources.

In summary, I want to stress that if the nation is to establish a workable alternative fuels program, much care needs to be devoted to how we manage the transition. If alternative fuel vehicles are to gain commercial acceptance, consumers must be confident both in the vehicles and in the availability of an effective fueling network to support the vehicles.

Whatever the fuels that will be required by future events, General Motors intends to remain at the forefront of this process.

Thank you.

[The prepared statement of Mr. Colucci follows:]

Record

Statement of

General Motors Corporation

before the

Senate Energy and Natural Resources Committee

Presented by

Joseph Colucci

November 14, 1989

Washington, D.C.

Good morning. I am Joseph Colucci, Department Head, Fuels and Lubricants, at the General Motors Research Laboratories. I am also Co-Chairman, with Dr. Keith McHenry of AMOCO, of the Joint Auto/Oil Program's Research and Planning Task Force. I am pleased to have the opportunity to share with you General Motors' progress and plans in the development of vehicle applications for alternative fuels. In addition, I would like to discuss some of the issues that will be key to sensible and successful implementation of an alternative fuels program for our nation.

Introduction

Although we believe that gasoline is likely to remain the primary motor fuel in the foreseeable future, General Motors has conducted substantial research into the potential of many alternative fuels to extend or replace gasoline and diesel fuel. We recognize that the use of alternative fuels may provide a strategy for addressing concerns about energy security and environmental quality. However, we also realize that the task of implementing a workable alternative fuels program is extremely complex.

For example, the most effective strategy for using alternative fuels to help achieve cleaner air does not necessarily require their use on a nationwide basis. A regionalized approach would initially provide opportunities for air quality relief where it is most needed. It would also provide opportunities to prove the new technologies required for alternative-fuel vehicles and to develop the infrastructure required to support fuel production and distribution.

Successful introduction of any alternative fuel for national transportation demands will depend, not just on the availability of technology, but also on the resolution of an array of other factors, including economics, supply and distribution considerations, safety and, most importantly, consumer acceptance. Each of the major fuel alternatives for current gasoline --the alcohols, including ethanol and methanol, reformulated gasoline, compressed natural gas, liquified petroleum gas (LPG), and electricity -- has unique characteristics with respect to these factors, as well as to their environmental and health-related impacts.

Independently, General Motors is also taking steps to promote the current use of cleaner fuels for the existing vehicle fleet. Gasoline containing oxygenates acts to make the engine's air-to-fuel ratio leaner, and this can result in less carbon monoxide emissions. Beginning in the current model year, we are recommending in our owners' manuals the use of properly-blended gasolines containing oxygenated components. These fuels are also now recommended for our previous model year vehicles.

Oxygenate blending components can be used in gasoline and they do not require modification of existing vehicles. This applies to older, open loop and current closed loop fuel metering systems. Ethers, such as methyl tertiary butyl ether (MTBE) and ethyl tertiary butyl ether (ETBE) can be used in the blends year-round because they do not increase gasoline volatility. Alcohols when added to gasoline increase its volatility and this results in increased vehicle evaporative and running loss emissions.

To date, our work at General Motors has focused on the alcohols. We are looking at alcohol use in several ways. Currently, all of GM's gasoline burning vehicles are designed to use alcohols as oxygenated components in gasoline. In this application, the alcohols, either in the gasoline directly or in the form of ethers, are used at low level concentrations, not to exceed 3.7 mass percent oxygen in the gasoline.

We are also looking at the other end of the spectrum - high alcohol content fuels. Here we are pointing toward M-85 (85 percent methanol, 15 percent gasoline) in variable-fueled vehicles designed to operate on any combination of fuels from pure gasoline to these high alcohol concentration blends. These vehicles can also use ethanol in place of methanol.

Two other fuels are also receiving considerable attention at GM - compressed natural gas and reformulated gasoline - because of their potential as alternative fuels in the 1990's. For the longer term, we're also looking at other ways to use fuels to reduce vehicle emissions. Primary emphasis is on dedicated alcohol fuels (M-100) in spark-ignition engines, fuel cells using methanol, and battery powered vehicles using electricity generated from environmentally-sound power plants.

Our statement today will concentrate on three alternative fuels for which we see particular promise in the 1990's: reformulated gasoline, methanol and natural gas.

Reformulated Gasoline

General Motors' interest in reformulated gasoline stems from a growing awareness that an effective transition is the key component of any alternative fuels program. Earlier this year, General Motors published a paper "Automotive Fuels for the 1990's - Challenges and Opportunities," which stresses the potential for reformulating gasoline to reduce vehicle emissions. Specific compositional changes, including use of oxygenates, were proposed.

The major point of the paper was that changes in gasoline composition to reduce vehicle emissions would provide great leverage in improving air quality because the reformulated gasoline could be used in the existing vehicle fleet, which will remain the largest source of vehicle emissions for many years. Reformulated gasoline is the only means of reducing emissions from the existing vehicle fleet that would not require changes in the behavior or expectations of the consumer. Thus, even a relatively small reduction in vehicle emissions can have a large and rapid impact if it applies to essentially all passenger vehicles on the road today.

General Motors has made a major commitment to investigate reformulated gasoline as an alternative to current gasoline. On October 17, 1989, GM, together with Ford, Chrysler and 14 major oil companies, announced a comprehensive joint research and testing program to evaluate fuels for use in current and future model cars and light-duty trucks. The program will complement President Bush's Clean Air Act Proposal, which for the first time considers both cars and trucks and the fuels they use. The project will involve prominent environmental researchers from both academia and government.

The research program has two phases. The initial phase, now underway, will seek to determine the emissions and air quality effects of various methanol fuels used in prototype vehicles, and of reformulated gasolines used in current, as well as past, model vehicles.

The methanol fuel vehicles will be prototype variable fuel, flexible fuel and gasoline-tolerant methanol vehicles being developed by the auto manufacturers. The current model vehicles will contain the newest technology emission control systems. Also in the test fleet are older high volume vehicles which are expected to remain in use during the 1990's. The various types of reformulated gasoline will be created by varying aromatics, olefins, and oxygenate levels and the amount of components with higher boiling points. Additionally, ethanol and sulfur levels will also be examined.

During this phase of the program, all types of vehicle emissions - exhaust, evaporative and running losses - will be measured. These emissions will be characterized to determine specific chemical constituents by using sophisticated gas chromatographic techniques. The data from all of these analyses will then be used in atmospheric chemistry and air quality models to determine the potential reductions in urban ozone from use of any of the tested fuels.

A second phase of the research program is now under development with a projected start next year. This program will use information from the initial phase to conduct research on advanced technology alternative fuel and gasoline-powered vehicles (future production vehicles). Other alternative fuels, such as compressed natural gas and neat alcohols, will be considered for inclusion in this phase of the program.

Part of this effort will explore the impacts on emissions and air quality by systems optimization involving current and reformulated gasolines and various vehicle emission control parameters.

Methanol and Variable (Flexible) - Fueled Vehicles

General Motors is also concentrating on the development of variable fueled vehicles, that can operate on gasoline or other alternatives, rather than dedicated alternative fuels vehicles. The variable fueled vehicle would represent a necessary step in the transition to alcohol fuels because of the current absence of an alcohol-fueling infrastructure. Until such an infrastructure is fully operational, consumers would be hesitant to invest in vehicles that depend on nontraditional fuels with limited availability. Realistically, assuming alcohols can be economically competitive with gasoline, we think the transition to dedicated vehicles would take at least ten to fifteen years, and even this timetable would require an aggressive program with a national commitment — similar to that required to put a man on the moon twenty years ago.

GM has been conducting field tests with cars and buses fueled with methanol and other alcohols since 1983. Our early work focused on solving technological issues in the laboratory. We are now doing more broadly based vehicle testing in several programs. We hope to use the information from these programs to help us understand the issues associated with introducing alternative fueled-vehicles on a commercial basis.

We are pleased to be participating in the California Energy Commission's Methanol Fuel Flexible Vehicle Demonstration Program — currently the largest yet announced variable-fueled fleet program in the U.S. Between now and 1992, General Motors will supply 2,220 vehicles, as well as special service training and support, to the project. These vehicles will be equipped with GM's newly developed variable fuel control system that allows operation with M85 (a mixture of 85% methanol and 15% unleaded gasoline), gasoline, or any mixtures of gasoline and alcohol (including ethanol), depending on the fuel chosen by the operator.

In the first phase of this project this year, we supplied 20 Chevrolet VFV's with 2.8-liter V6 engines. The delivery of 200 Chevrolet Luminas will occur in 1991, followed by the remaining 2.000 Luminas in 1992. All of the Luminas will have modified 3.1-liter V6 engines.

One of the reasons for our participation in this major demonstration program is to accelerate the validation of designs for alcohol-fueled vehicles. We have essentially redesigned the entire fuel system of the vehicles that will be delivered in this program. In addition to GM's proprietary fuel composition sensor, fuel system modifications now include stainless steel fuel tanks, teflon lined fuel hoses, and other upgraded plastic and polymeric components. There have also been some changes in the metallurgy of several engine components. To the extent that use of such premium materials proves necessary for production vehicles, it will obviously impact the cost of alcohol-fueled vehicles which could ultimately affect market acceptability of VFV technology as well as market demand for these vehicles.

General Motors has also participated in a demonstration program with the Department of Energy and Argonne National Laboratories focusing on light-duty trucks. In 1986, we delivered five Chevrolet S-10 trucks which operate on M-85, except for a gasoline cold start system, and five gasoline-fueled trucks for comparison purposes. These vehicles are still being tested, and we have benefited considerably in gaining information on material compatibility with the M-85 fuel.

GM recently cosponsored the 1989 SAE Methanol Marathon to explore, under real-world conditions, the advantages and challenges of methanol as an alternative fuel. Fifteen student teams converted vehicles provided by GM to operate on M85 and subsequently competed in a five-day, 1,100-mile road rally from Detroit to Washington, D.C. Our participation in this event contributed to growing public interest in alternative fuels applications and also provided us some useful ideas for methanol vehicles.

GM has engaged in a variety of other programs to build our knowledge about dedicated and variable-fueled vehicles. We have gained valuable experience in areas such as material compatibility and engine calibration from working with dedicated ethanol-fueled vehicles in Brazil. We have worked with the Detroit Diesel Corporation (formerly GM's Detroit Diesel Allison Division) on a program to develop methanol-fueled transit buses. We have also been actively studying the use of alcohols in a variety of engine types, including the conventional spark ignition and compression ignition engines, and prototype direct-injection stratified-charge and gas turbine engines. Our current program includes futuristic technologies such as fuel cells which offer great potential for high efficiency and low emissions, particularly in large vehicles such as locomotives and trucks.

General Motors alcohol vehicle programs continue to focus on solving tough engineering problems such as cold start, driving range, material compatibility, lubricant formulation, and control of formaldehyde emissions. Our scientists are working on developing catalysts for alcohol-fueled vehicles which focus on control of formaldehyde emissions. There are also unresolved questions regarding the extent of the potential air quality benefits of methanol and the toxicity of methanol. This latter point is extremely important to consumer acceptance and use at self-serve fuel stations.

Moreover, fuel specifications are an open issue that must be resolved especially in view of the impact on long-term emission control durability. However, although many engineering refinements are still necessary to commercialize the use of methanol, we believe methanol could provide one alternative for this country's transportation sector if available at prices competitive with gasoline.

Natural Gas

Especially as a fleet fuel for urban areas, another potential alternative fuel is natural gas. GM is currently pursuing natural gas for these types of opportunities.

Natural gas, when used directly as an automotive fuel, does not undergo the energy losses involved in transforming it to methanol. Environmentally, it provides potential for reducing ozone formation because of its very low emissions of reactive (non-methane) hydrocarbons and aldehydes. The major problems with natural gas are on-board fuel storage and refueling. Based on current technology, using high-pressure gas cylinders, vehicle range is severely constrained compared with gasoline and even methanol. This leads us to conclude that natural gas application should, at least initially, be in centrally fueled fleets. This allows building dedicated natural gas vehicles, as opposed to dual-fuel gasoline-natural gas vehicles, with savings in fuel system cost and the space for gasoline storage.

GM's current natural gas programs are focused on fleet application. We are working with several outside organizations to develop fuel systems and engines. We believe more research is needed about on-board natural gas storage systems. Also, we are doing internal research to optimize engine performance on natural gas, and to minimize emissions, especially that of methane which is a potent greenhouse gas. We also intend to compare the ozone reducing benefits of vehicles fueled with current and reformulated gasolines, M-85 and natural gas.

Implementing Alternative Fuels

Although we are making major progress, considerable uncertainties remain about how alternative fuels programs will fare. Numerous questions about materials, durability and operating conditions are still to be resolved satisfactorily. Much is yet to be discovered about issues such as anticipated air quality benefits, health effects, toxicity and the impacts of such fuels on global climate change. But the greatest gap in our knowledge base is the consumer.

We know very little about how consumers will respond to alternative fuels and vehicles that use them. Nor do we know the best ways to win consumer acceptance of alternative fuels programs. For these reasons, we have serious doubts about the outlook for any program that mandates the sales of alternative fuels vehicles.

General Motors supports S. 1490's clean fuels program as an innovative approach to promote clean air objectives. However, we do not believe auto manufacturers should be required to guarantee specific sales volumes. Instead, our responsibility should be to provide adequate production capacity to offer vehicles for sale in the required numbers. In that form, the clean fuels program would still represent an extremely aggressive program that will stretch our resources.

If alternative-fueled vehicles are to gain commercial acceptance, consumers must be confident both in the vehicles and the availability of an effective fueling network to support these vehicles. States that participate in the clean fuel program should adopt measures to encourage the purchase of these vehicles and the expansion of commercially acceptable fuel distribution systems. Additionally, the efforts of manufacturers to develop alternative-fueled vehicles could be facilitated by taking steps to streamline and simplify certification and testing requirements for alterative-fueled vehicles.

We continue to believe that the establishment of additional alternative fuels pilot programs would provide necessary experience to facilitate the transition to larger alternative fuels programs. Such programs should: include broad-based participation by governments, vehicle manufacturers, energy companies and consumers; be focused in other nonattainment areas besides Los Angeles; and, provide a minimum of two- to three-years' experience in order to collect information regarding technical, market acceptance, fuel availability and economic questions.

There is an obvious need for coordination between the policymakers and the industries impacted, so that available resources can be focused properly. Public policymakers must recognize that requirements for manufacturers to produce a broad range of vehicle types in a short timeframe are very demanding of our resources, with much potential for inefficiencies and redundancies.

In summary, I want to stress that if the nation is to establish a workable alternative fuels program, much care needs to be devoted to how we manage that transition. Regardless of what alternative fuels may be required by future events, General Motors intends to remain at the forefront in developing technologies that can use them. We are in the business of providing transportation systems for our customers, and we intend to continue to do so.

The CHAIRMAN. Mr. Dickinson.

STATEMENT OF WILLIAM S. DICKINSON, MANAGER, ENGINEERING AND TECHNOLOGY, ARCO PRODUCTS CO.

Mr. DICKINSON. Mr. Chairman, my name is William Dickinson. I am Manager of the Engineering and Technology Group for ARCO Products Company. ARCO manufactures and markets petroleum products in the five western states.

Thank you for permitting us to share our views with the committee on the future of reformulated gasoline. We have submitted written testimony and I will talk about the highlights.

First, it is our company's view that the gasoline internal combustion engine will be with us for quite some time, certainly a minimum of 15 years and probably much longer.

Second, vehicle emissions can be significant contributors to smog formation in some, but not all, areas of the country. They are a problem in our largest marketing area, Southern California.

Third, with the President's environmental agenda and plans by the Southern California Air Management Agency to mandate a methanol blend as an alternative vehicle fuel, ARCO decided to attempt to develop a cleaner-burning gasoline, so we went to work.

The result, on September 1st, 1989, ARCO introduced a reformulated regular gasoline to take the place of our leaded regular gasoline. The product is called EC–1—emission control, first in a series.

EC–1 is an environmentally engineered gasoline formulated to reduce emissions from older vehicles that burn regular leaded gasoline, the pre-catalytic model vehicles. Namely, the pre-1975 cars and the pre-1980 trucks. These older cars and trucks are only 15 percent of the vehicles in Southern California, but they account for 30 percent of the vehicular air pollution.

If every user of leaded gasoline in Southern California switched to a low emission gasoline like EC–1, it would be like removing 20 percent of those vehicles from the road, or right now removing 320,000 vehicles from the highway. If that switch were made, over 350 fewer tons of pollutants would enter the air of Southern California each and every day.

We have provided a copy of our technical report on EC–1 for your record. We believe that reformulated gasoline like EC–1 will turn out to be the most effective smog-control measure since the catalytic converter. I want to point out that this creative solution was not mandated.

Our next task is to develop reformulated gasolines for newer cars. We know it will help, because we have been testing EC–1 in new cars. The studies are preliminary, but we are very encouraged.

We are confident that more improvement will come as we work with the auto companies on a joint research project of even more effective reformulated gasolines, engines and emission control systems, but to get there quickly and at reasonable expense, we need a willingness on the part of Congress and the regulators to let creative minds work together to find practical solutions to meet standards set by government.

How good will EC–X be? We believe that a goal within our grasp is a fuel engine emissions control system comparable to a flexible fuel vehicle using M-85. We may do better. Less is not good enough.

How soon will we have answers? Within one year, we will have answers on reformulated gasolines in today's cars. It will take several years to get answers for newer designs.

What does the petroleum industry need to make this happen? We need a level playing field where all fuels have a competitive shot at meeting the government's performance standards.

A mandate for a particular fuel like methanol will stifle our efforts and secondly, if we are successful in developing an EC-X type gasoline we cannot have our hands tied by permit conditions so tough that we could not modify our refineries to manufacture the product.

In closing, let me make five points: (1) reformulated gasolines like EC-1 can make a contribution to improved air quality today.

(2) We believe that EC-X, the reformulated gasoline of the future, will be as good as M-85 in a flexible fuel vehicle.

(3) EC-X gasolines will have the added bonus of reducing emissions from all catalytic vehicles.

(4) While our industry was under pressure to come up with an environmentally better product, the EC-1 solution was neither prejudged nor mandated. It was a product of creative minds and technology trying to solve a problem.

Prejudging and mandating solutions stifles creativity and freezes solutions to today's and tomorrow's problems with yesterday's answers, no matter how far ahead we think we can see.

I would like to repeat that because I think it is really important: that prejudging and mandating solutions stifles creativity and freezes solutions to today's and tomorrow's problems with yesterday's answers.

Finally, a big uncertainty is that once EC-X is developed, whether we will be able to adapt our refineries to commercially produce it because of increasingly tough permit conditions.

Let me again express our appreciation for permitting us to share our views with the committee about reformulated gasoline. I would be happy to answer any questions.

[The prepared statement of Mr. Dickinson follows, the EC-1 report has been retained in committee files:]

TESTIMONY OF

ARCO PRODUCTS COMPANY

TO THE

COMMITTEE ON ENERGY AND NATURAL RESOURCES

UNITED STATES SENATE

ON

REFORMULATED GASOLINE

PRESENTED BY

WILLIAM S. DICKINSON

NOVEMBER 14, 1989

WASHINGTON, D.C.

Testimony of W.S. Dickinson
ARCO Products Company

Senate Energy and Natural Resources Committee
November 14, 1989

INTRODUCTION

My name is William S. Dickinson. I am Manager - Engineering and Technology for ARCO Products Company, a Division of Atlantic Richfield Company. We manufacture and market petroleum products in the five Western states. We appreciate the opportunity to share with the Committee our company's views on the future of reformulated gasoline in the energy mix that will power the nation's vehicle fleet well into the next century.

THE ENERGY AND ENVIRONMENTAL POLICY DEBATE

As a nation, we are engaged in two policy debates - each of which conflicts, in some measure, with the other - namely energy policy and environmental policy. The problem, as I see it, is, "How do we resolve the gulf between these two vitally important issues in a way that makes rational sense from each perspective?" It is my company's view that reformulated gasoline will play a key role in bridging the gap between the nation's energy and environmental concerns and I would like to share that view with you.

Before getting to the issue of reformulated gasoline, I would like to lay out for you our concept of the bounding framework of the debate as it relates to mobile source emissions. As a basic conclusion, we believe that petroleum products - including some form of gasoline - will play a key part in the fueling of vehicles well into the next century. There are a number of arguments that support this conclusion that are best left to resource economists to propound. Aside from the factors of availability, price, convenience, consumer acceptance and existing infrastructure, the simple fact is that there are some 136 million vehicles on the road today in the United States that use gasoline as a fuel. These vehicles will be with us for 15 years or more and their fuel needs must be met. Further, we believe that the gasoline internal combustion engine will continue to be the chief means of powering vehicles well into the next century. Moreover, the design of the gasoline internal combustion engine has evolved and will continue to evolve to meet society's demands - in power, performance and environmental concerns.

At some point in the future - and I do not have the expertise to predict when - fossil fuel availability limitations will force a change in the energy source for vehicles. Creative technology, resource availability, environmental considerations and the market place will dictate what form that energy source will take. I do not want to speculate on what that course will be for we have before us a more immediate and pressing task that needs to be addressed - a focus on our current situation as it relates not only to energy, but to the environment, as well.

Another fact is that in some areas, such as Los Angeles, mobile source emissions are a major factor in the generation of pollutants which are precursors to the formation of tropospheric ozone, namely reactive organic gases (ROG) and oxides of nitrogen (NOX), not to mention another criteria pollutant of concern, carbon monoxide. Clearly, these mobile source emissions must be reduced in some [but, importantly, not all] areas if we are to make progress toward reducing smog to levels acceptable to the American public within acceptable time limits.

THE ROLE OF REFORMULATED GASOLINE IN THE ENERGY/ENVIRONMENT DEBATE

The debate on Clean Air is wide-ranging and complex. Rightly understood, the Clean Air debate should not lend itself to simple command-and-control solutions. More about that later. One segment of this debate deals with emissions of pollutants from mobile sources and it is in that context that we will discuss the role of reformulated gasolines.

Perhaps the best way to get at the subject is to pose a series of questions and then provide you with insight that is based on ARCO Products Company's experience and expectations with the development of a reformulated gasoline. Without appearing overly immodest about the obvious commercial aspects of our product, you may be aware that ARCO developed and we are now marketing a reformulated gasoline in Southern California. We have named the product EC-1. The acronym stands for "emission control" gasoline, the first of a series. For simplicity's sake, subsequent reformulated gasolines will be called EC-X, for we expect that there will be more than just one in the series.

The product is not proprietary. We have given the formula to others in the industry and we are making the specifications widely available through the American Petroleum Institute.

Through the introduction of EC-1, ARCO has made a public commitment to improve the emissions characteristics of today's older cars. Further, we have made a public commitment to improve the emissions characteristics of newer cars through the development of EC-X, the next generations of reformulated gasolines. To accomplish this task, we will need a level playing where all fuels can compete - not a mandate for a particular alternative fuel such as methanol. Moreover, presuming that we are successful in developing an EC-X that delivers a high degree of emissions performance, we will need regulations that do not tie our hands so tight that we cannot manufacture it.

As we move on to the discussion about reformulated gasoline, the question/answer format below will use the ARCO terms EC-1 and EC-X for reformulated gasolines.

What is EC-1?

EC-1 is an environmentally engineered gasoline which has been formulated to reduce emissions specifically from older vehicles that burn regular leaded gasoline - the pre-catalytic model years which are the pre-1975 cars and pre-1980 trucks. EC-1 is formulated to decrease the overall level of both evaporative and unburned hydrocarbon emissions, including toxic components, that react with other pollutants in the air to form ozone, one of the major components of smog. Specifically, we made the following changes to conventional gasoline:

- Aromatics have been reduced substantially - to 20 volume percent - to reduce both the volume and reactivity of unburned hydrocarbons [reactive organic gases] that are emitted from the exhaust,
- Benzene has been cut in half - to 1 volume percent - to reduce the toxicity of this conventional gasoline component in anticipation of California standards,
- Vapor pressure has been reduced one pound below the California standards - year around - to reduce evaporative reactive organic gas emissions during

storage, refueling, and vehicle operation,

- Sulfur content has been substantially reduced - to no more than 300 parts per million - to minimize the formation of particulate matter (sulfates) which are precursors of acid rain - [this is a California standard for unleaded gasoline],
- Lead content has been eliminated to remove this criteria pollutant as well as to eliminate "misfueling" of unleaded vehicles with a leaded product [EC-1 qualifies as an unleaded gasoline but it is not marketed through unleaded gasoline pumps],
- To enhance the octane (in place of lead and aromatics) we have added MTBE (methyl tertiary butyl ether). MTBE has the beneficial effect of adding oxygen to the fuel (not less than one weight percent in this case) which reduces both carbon monoxide and hydrocarbon emissions during combustion.

Where is EC-1 Useful and What will It Accomplish?

EC-1 was formulated for use by older vehicles [pre-catalytic converter equipped] in Southern California - an area well known for its unique and egregious smog problems. These older cars and trucks constitute only 15 percent of the vehicle population in the area, but they are responsible for 30 percent of the vehicular air pollution. We designed EC-1 to clean up the emissions of these heavy polluters and it's working. Independent tests have confirmed that if every user of leaded gasoline in the Los Angeles Basin switched to a low-emission gasoline like EC-1, it would be like removing 20 percent of those old vehicles right now - the same as eliminating 320,000 of those vehicles from the road.

If that switch were made, over 350 fewer tons of pollutants would enter the air of Southern California every day and this is a conservative estimate. If you make some reasonable assumptions about misfueling ["misfueling" is the use of leaded gasoline in an unleaded vehicle which has the effect of poisoning the catalyst and rendering it inoperative], we could get pollutant reductions of as much as 600 tons per day. Based on air quality modelling, peak ozone levels would be cut by about 2 percent. In a word, we believe that reformulated gasoline like EC-1 will turn out to be the most effective smog control measure since the catalytic converter was introduced 15 years ago.

Not to minimize the potential beneficial impact and success of EC-1, there is one thing that should be remembered. This is a temporary solution to a problem that is diminishing as the older cars wear out. The newer cars that would replace the older pre-catalytic models have greatly improved emissions characteristics. Even so, what we learn from EC-1 will be useful as we go about developing the next generations of reformulated gasolines - EC-X.

What is the History of the Development of EC-1?

Historically, gasoline has been formulated chiefly on the basis of performance and cost - to meet the demands of the consumer. Refining processes - the way gasoline molecules are arranged -were tailored to achieve these results. But now there is a new factor in the equation of consumer demand, namely, environmental performance. To fit this environmental demand into the picture in a rational way, ARCO needed the computerized air quality models of the Los Angeles Basin developed by the relatively new and rapidly evolving science. Moreover, we needed help from technologists in measuring the impact of auto exhaust on the atmosphere. A rational way to put all the factors together is a relatively recent development.

And, to be candid, we needed a little shove to get us moving. The President's environmental agenda and the South Coast Air Quality Management District's (Southern California's air quality management agency) proposal to mandate methanol made us see the virtue of reformulating our gasoline - quickly.

And there is another important factor that was operating, too. All of the testing of EC-1 as well as the projections on what it would do for emissions was done by independent laboratories and consultants [we will be pleased to supply the Committee with a set of these reports, if that is the Committee's desire]. But, we had to have confirmation by the California Air Resources Board [the state agency that controls mobile source emissions] and the South Coast Air Quality Management District that what we were proposing with EC-1 was a real improvement in vehicular emissions reductions and not just public relations hype. So, in the development process, we shared our ideas and test data with these agencies. If these agencies had not validated our results, we would not have gone on with the project. And there is a lesson to be learned here, as well. Relationships between the regulators and regulated can be cooperative and need not always be adversarial - arms-length, certainly, but not confrontational.

One key point needs to be made here. The EC-1 solution was not mandated either by law or regulation. Rather, EC-1 is an example of top creative technical minds and management coming together to try to develop solutions to a problem using a mix of both established and evolving technology. Under pressure? Yes. But, solutions were neither prejudged nor mandated. Prejudging and mandating solutions are hallmarks of the command-and-control approach to dealing with regulation - an approach that stifles creativity and freezes solutions to today's and tomorrow's problems with yesterday's answers [no matter how far ahead we think we can see].

The command-and-control approach to regulation characterizes much of the Clean Air Act legislation - both enacted and proposed. Instead, we would suggest that the role of government is to set performance standards and then let the creative talents of industry and the market place develop the best ways to achieve these goals. We are talking about a level playing field in which all comers have a competitive shot at getting the job done. This is the atmosphere in which creative juices flow and we are going to need all the innovation we can muster to arrive at acceptable solutions to both the energy and environmental concerns that we face as a nation. The development of EC-1 is a prime example of this type of creative problem solving.

Moreover, as business people, we have an intense and legitimate interest in the efficiency and cost of the environmental programs on which we embark. Saying yes to one set of expenditures means that we also say no to another set of expenditures. In a word, we believe that it is best to get the job done in the most efficient manner and at the least cost. Clean air is expensive. The nation spends about $35 billion per year on it now. Prospective legislation may run that cost well into the range of $70 to $100 billion per year. There are many worthwhile demands that compete for these same resources and we need to use our resources wisely and effectively. Furthermore, we can only spend at a pace that is consistent with the consumer's willingness to pay for the improvements.

What is the Outlook for EC-X Gasolines?

What about newer cars? Can reformulated gasoline help them? The unqualified answer is, yes it can. We know because we have been testing EC-1 in newer cars. While these studies are only preliminary, and there is much work to be done, we are very encouraged by the results. And we are confident that further improvement will come as we work with the automotive industry on even more cost-effective fuels and vehicles to get at this environmental concern.

Oils and autos are not exactly strange bedfellows. But the degree of cooperation I am talking about is unprecedented. A task force of the leading auto and oil companies is doing the joint research. This effort was started by and has the full support of the CEOs so you can be assured that the project will get serious attention. The oil/auto joint research and testing program was announced on October 17, 1989 by three domestic companies and 14 petroleum companies. Prominent researchers from universities and government will be involved.

We are looking at reformulated gasoline that can be produced in existing refineries, because there is not much chance of siting any new refineries in the United States. And we are trying to find answers for alternative fuels as well such as methanol and methanol/gasoline blends that can be used in the cars of the future.

With hard work, resources and creative talent, the combination of an EC-X type gasoline and further work on engine design and emission control systems will provide the best solution to mobile source emissions. To repeat, the successful outcome of this enterprise will depend on a systems approach. But to get there quickly and at reasonable expense, we need a willingness on the part of Congress and the regulators to let those creative minds work together to find practical solutions to meet standards set by government.

What will EC-X Look Like?

Can we tell you precisely what EC-X will be? The short answer is, no. We can tell you the direction that it is headed, but until we work out the optimal fuel design in combination with engine and emissions control systems design, we cannot be precise. The first round of oil/autos' research - reformulated gasolines in current technology engines and emissions control systems - will provide answers in about one year. The second round of research - reformulated gasolines in newer technology engines and emissions control systems - will be more complex and may take several years.

In a word, we cannot prejudge the solution - there are too many unknowns at this point in time. But we believe that we know enough to say that substantial improvements are almost within our technological, manufacturing and resource availability grasp. We are talking about solutions that are achievable in the very near term based on a reasonable extension of known technology - not solutions based on a massive change-out to unknown technologies, unknown consumer acceptance, undeveloped resource bases and infrastructure whose time frame to accomplish would be unpredictable.

As I said at the start of this testimony, fuels and engines have been evolving to meet consumer demands and resource availability ever since they were first introduced and mass produced. There is no reason to think that this evolutionary process will suddenly stop. In fact, technology is improving at an exponential rate. Even today's vehicle fleets with today's conventional fuels have reduced hydrocarbon emissions by over 90 percent of what they were during pre-control levels. This is a strong record of achievement for the auto industry. Working together, we believe we can do even more.

The next logical question is, "How good will EC-X be?" As we move from the known to the unknown - in terms of fuel formulation, engine and emissions control design, the answer, of necessity, has to be in the form of speculation. Nevertheless, we believe that a goal realistically within our grasp is to have a fuel/engine/ emissions control system that is essentially comparable to a flexible fuel vehicle using M85 - a mixture of 85 percent methanol and 15 percent gasoline. We may do better. Anything less would not be good enough.

Performance Standards

Which brings us to the subject of performance standards. As I said earlier, industry may need a shove to get moving - technology forcing standards, if you will. But those standards should be set by balancing several key factors: (1) they should consider what is necessary to get the job done, i.e. what reductions are necessary from the mobile source sector to attain air quality improvement goals - not just controls for control's sake; (2) they should be feasible - tough, perhaps, but feasible - from a technological and economic standpoint; (3) they should consider the resource base most likely to be abundantly available - and in use - during the time the standards are to be enforced; and (4) the performance standards should have stability - not continually changing - to give industry a target both for planning and stability of investment. We would expect the standards to be stringent, but at the same time the targets should be realistically within the grasp of industry on a massive scale.

With respect to the development and implementation of control strategies for clean air, the Clean Air Working Group (CAWG), a multi-industry coalition working with clean air legislation - has proposed [so far without much success] that Clean Air Act legislation should embody the principle of an Advance Planning Program (APP). Briefly, APP is a decision making process and an action tool that could play an important part in the setting of performance standards for mobile sources. The formula for an "Advanced Planning Program" can be simply stated:

(1) Analyze the local air emissions situation (all air sheds are different) - including inventories, source characteristics, meteorology;
(2) For the controls that have been imposed, find out what worked, what didn't and why;
(3) Determine what more needs to be done to attain the standards (where, what, how much);
(4) Develop an array of control measures and project their specific contribution to air quality improvement - using a combination of actual experience and modelling (or other suitable analytical techniques);
(5) Rank order the control measures in terms of cost per unit of air quality improvement [this is a different measure than cost per ton of emissions reduced or number of tons reduced from the inventory - both of which only indirectly, if at all, address the air quality problem,

whereas the suggested criterion - unit of air quality improvement - directly addresses the air quality attainment goals of the Clean Air Act];

(6) Implement in rank order those control measures that improve air quality the most for the least cost [as near as possible] until the standards are attained;

(7) Continue reality checks to make sure that the strategies are sound and are doing the intended job. Make mid-course corrections as necessary.

Some of the Advance Planning Program is in S 1630 and in the other bills being considered, but much is not. Much of the Advanced Planning Program is not now being done in the current planning process and that is where the system is breaking down - despite the reams of "planning" documents.

If the Advance Planning Program were fully implemented, we would have a better idea not only of the mobile source emissions inventory, but more importantly, what portion of that inventory would have to be reduced in order to achieve the health based National Ambient Air Quality Standards (NAAQS). This information, then, would be a key consideration in the setting of performance standards for mobile sources. Further, APP would provide the needed insight on the effectiveness of such a proposed control strategy.

APP would likely suggest different mobile source performance standards for different non-attainment areas depending on the severity of the non-attainment situation and unique local conditions. This would be an unacceptable outcome for the simple reason that it would be extremely costly to provide special fuels/engines/emission control systems for each different area - not to mention the fact that vehicles move from area to area, thus prospectively defeating unique methods of dealing with a local problem. One way out of this dilemma would be to have two basic sets of performance standards - one for areas with severe nonattainment problems [such as the nine areas suggested in the President's bill] and one for those areas that are only moderately impacted - or not impacted at all - with smog problems. Such an approach would more closely track what is happening in today's world of performance standards. The point of this dual approach to performance standards is to maximize the efficiency with which we attack the air quality improvement problem while at the same time minimizing the cost of improving air quality. You will recognize that the fundamental assumption of this approach is that we would be improving air quality to meet the national health based standards, but that resources expended beyond that goal could better be used for programs of national concern such as education, health care, homelessness, crime, social security, and other important national needs.

Less there be some misunderstanding about the Advanced Planning Program, three points need to be made:

(1) Ideally, an Advanced Planning Program would follow a stepwise process. As a practical matter, we now have a command-and-control approach to air quality management that has been institutionalized for some 17 years, and that is not likely to change quickly, but change it must. In any case, APP can logically be superimposed on (and run in parallel with) the current system. If it can be done, we believe we will be able to reach our clean air goals in a faster and more reliable way - with the added bonus to the public that it will likely cost less. The benefits will be lost if we continue the present course.

(2) Does advance planning mean stopping progress or delaying deadlines? In our view, the answer is no. Despite reports to the contrary, the Clean Air Act is alive and well. The Administrator as well as the state boards and local air quality management districts are proposing and implementing rules daily. This will continue. California Air Resources Board mobile source standard proposals, SIP revisions, RVP reductions, new source reviews, new state and local rules are but a few examples.

(3) As a practical matter, we cannot visualize that mobile

> source performance standards would be put off until the initial round of an Advanced Planning Program is completed - two, possibly three years. But we can visualize the use of two different (nonattainment severity based) standards until such time as the necessary information is developed to justify a more stringent action. In a word, we do not advocate backing off or stopping progress in the mobile source emissions area - for these efforts already have a momentum which is not likely to be slowed down, much less stopped. We do advocate an analysis and decision process that attempts to understand what the problem is and the best method for dealing with it.

An Advanced Planning Program (actually a continuous review and decision process) is a rational way of dealing with the subject of mobile source standards. In our view, such an approach will ultimately prevail. We should get it going now and not wait until another five or ten years of failure - not to mention ineffective use of resources - forces us to do it right.

Where would be the Appropriate Use of EC-X Type Gasolines?

A gasoline such as EC-1 is likely to have wide application both in the short-term (1990 to 1995) as well as in the long-term (1996 plus - or as long as there is a significant population of pre-catalytic vehicles in operation). Basically, this is a cleaner burning fuel that can be manufactured - for the most part - with only limited changes in refining processes, with minimal additional costs, and requires no changes in existing vehicle technology. Since our company does not market nationwide, we cannot speak for the entire industry. But in our view, its use would be appropriate in all nonattainment areas - regardless of severity. The near term benefits would be substantial and the costs would be minimal (in the longer term, the older cars will be replaced, thus doing away for the need for EC-1).

It should be pointed out that there may be some cases where EC-1 type gasolines could not be manufactured - even on a limited scale - without major refinery changes, simply because of either lack of equipment availability or plant configuration.

Manufacturing an EC-1 type gasoline now for the entire product slate, namely leaded, unleaded and premium, starts to become more problematic and could require major changes in refining processes which will result in additional costs - in some cases substantial. Since the newer vehicles (post-'74 cars and post-'79 trucks) have catalytic converters, the incremental benefit of reductions in emissions for the unleaded fleet start from a smaller base and cost-effectiveness starts to dwindle.

In the long-term (post-'95), EC-X gasolines would be formulated to have no more impact on air quality than emissions from M85 flexible fuel vehicles. Moreover, such a reformulated gasoline could also be used in pre-'96 vehicles, which would provide even more of an air quality benefit for those vehicles when compared to the use of conventional unleaded gasolines. We believe that the most cost-effective use of EC-X type gasolines would be in those nine areas that have the most severe nonattainment problems. The oil/autos research effort would provide a clearer insight on this issue.

What are the Economics of EC-1 and EC-X Type Gasolines?

As we said earlier, in most cases, the production of EC-1 type gasolines for use in pre-'75 cars and pre-'80 trucks - similar to ARCO's - can be accomplished without major changes in refinery processes. It does require the use of oxygenates such as MTBE (from methanol - from natural gas sources) or ETBE (from ethyl butyl tertiary ether - primarily from agricultural sources). Otherwise, there do not appear to be any major commodity market dislocations. We estimate a range of additional costs at 2 to 4 cents per gallon.

> [The current market for gasoline is 120-130 billion gallons per year. If 15 percent of this volume is converted to EC-1 type gasoline at a cost of 3 cents per gallon, the total cost

to the nation would be roughly $600 million per year.]

In the long-term (post-'95), the production of EC-X type gasolines are likely to have incremental costs in the range of 5 to 15 cents per gallon. Refinery processes will need to have major changes (more about the feasibility of this later) because the gasoline molecules will have to be physically rearranged differently than they are now in order to reduce the reactivity of unburned and evaporative emissions. Adding to the cost uncertainty is the fact that until the joint oils/auto research is done to optimize emissions reductions, we will not know what changes will have to be made in our refinery processes to produce the product.

[Assuming the same gasoline market base - 120-130 billion gallons per year, but this time assuming that EC-X will be more like 50 percent of the market with an incremental cost of 10 cents per gallon, total annual costs for EC-X to the nation will be more like $6 billion - $7 billion including the continued use of EC-1. Not included in these figures are costs that will be incurred by automakers to equip vehicles with differently designed engines and emissions control systems - which could add several additional billion dollars to the annual cost.]

The point being, even the costs for a dual performance standard system [nine most severe nonattainment cities in one group and the rest of the nation in the other] will be substantial.

With fuel neutral legislation, we are assuming that EC-X will be competitive with alternative fuels that may be considered in the market place. Certainly, we believe that EC-X with a total systems approach will be competitive in its impact on air quality with so-called leading candidates for alternative fuels such as methanol blends.

Other Considerations in Producing EC-1 and EC-X Type Gasolines?

The last point we want to make deals with the production of EC-X gasolines. As we said earlier, there is not much likelihood that new refineries coul be sited in the U.S. today to produce a different petroleum product. This is mostly because of the permit process and stringent conditions that are required, not to mention the delays created by the permitting process. Legislation now being considered with respect to permits is even more stringent than past practice and applies equally to modified sources as well as new ones. This raises the real question of whether our refineries could be modified to produce EC-X type gasolines.

Several of the bills being considered call for a federally approved permitting system with five year permits and renewals subject to modification as well as public hearings at each step of the way. Further, some of the bills call for a 90-day sign off by the U.S. Environmental Protection Agency. Even now, permits to construct or modify and operate can take as long as a year to get. A federal overlay on the permitting system could stretch this period out to two to three years. With three years to construct, that would leave two years of operation before new permits and major modifications could be required. This is a highly uncertain atmosphere in which to make major investment commitments. The point being that even if we are successful in developing an EC-X, there would be no assurance that we could construct or modify plants to produce it, or if we did, whether we could recover our investment due to new requirements. Such an atmosphere does not foster the risk taking and innovation necessary to solve our air quality management concerns. We would advocate more stability in the permitting process to allow for better business planning.

CONCLUSIONS

Finally, I would like to repeat several points.

- Reformulated gasolines such as EC-1 can make a contribution to improved air quality - now.
- We believe that EC-X, the reformulated gasoline of the future, can be designed to be at least as good as M85 burned in a flexible fuel vehicle. This outcome depends, in part, on the evolution of engine design and emissions control systems.

- EC-X gasolines will have the added bonus of improving the emissions from pre-1996 catalytic converter equipped vehicles.
- While we perceived that the gasoline industry was under pressure to come up with a product with better environmental performance characteristics, the EC-1 solution was neither prejudged or mandated. It was the product of creative minds and technology trying to solve a problem. Prejudging and mandating solutions stifles creativity and freezes solutions to today's and tomorrow's problems with yesterday's answers - no matter how far ahead we think we can see!
- One of the areas of greatest uncertainty is, once EC-X is developed, whether or not we will be able to commercially produce it because of prospectively increasingly stringent permit conditions.
- The costs to the public associated with more stringent mobile source performance standards will be substantial. We can only conclude that the public not only demands environmental performance but is willing to pay for it. Certainly, we will do our best to meet those performance demands.

Let me again express ARCO Products Company's appreciation for permitting us to share our views with the Senate Energy and

Natural Resources Committee about reformulated gasoline as it relates to the energy and environmental debate that engages the nation.

Thank you,

W.S. Dickinson
Manager - Engineering and Technology
ARCO Products Company
November 14, 1989

The CHAIRMAN. Thank you very much.

Mr. Colucci, I spoke with Roger Smith the other day about ETBE. He indicated his support for the concept of testing ETBE. Will that be included in the testing program?

Mr. COLUCCI. Senator, I am fairly confident that it will be. Our joint Auto Oil Committee is meeting tomorrow and we will have a final decision then.

The CHAIRMAN. What would your budget be on a joint research and testing program on that?

Mr. COLUCCI. The current budget is estimated to be somewhere between $11 and $12 million, but chances are it will increase as we increase the number of fuels included in the program.

The CHAIRMAN. Why do you say that a transition to dedicated vehicles will require a national commitment similar to that required to put a man on the Moon 20 years ago?

Mr. COLUCCI. Well, when you look at that, senator, if we are going to have dedicated vehicles across the United States we will need a massive change in the fueling system.

We are going to have to have—if it is dedicated methanol, we are going to have to have methanol distributed on a Nation-wide basis. We are also going to have to build many new plants to generate methanol from, whether it be natural gas or coal, and the time and the dollars involved to do this I guess would be equivalent to a commitment such as that to put a man on the Moon.

We still need more research, but we need the commitment in terms of building the capital facilities to provide the methanol, and as I am sure Mr. Dickinson would agree, that would take a large measure of effort on the part of the fuels industry.

The CHAIRMAN. How much work have you done on CNG? Do you know what is possible with a dedicated vehicle with CNG?

Mr. COLUCCI. We are very optimistic, senator, regarding CNG, because it should produce, and our test data do show this, very few, if any, reactive hydrocarbons, so CNG can, on a per-vehicle basis, be an excellent fuel. The real question is, how many CNG vehicles could you get into the population to make a significant impact on the overall emissions in a given area?

The CHAIRMAN. Well, how about with fleet vehicles?

Mr. COLUCCI. I think you can supply CNG to the fleet vehicles and you can greatly reduce their emissions of reactive hydrocarbons.

The CHAIRMAN. That would make a big dent, would it not?

Mr. COLUCCI. It would make a significant dent in cities such as Los Angeles.

Mr. CHAIRMAN. Or indeed, Washington, D.C.?

Mr. COLUCCI. Sure.

Mr. CHAIRMAN. Would it not be quite practical to do that with buses, cabs, other fleet vehicles?

Mr. COLUCCI. You could do that with retrofit systems, but what we would like to have is an excellent retrofit system so that we know it is done well.

The worst thing that can happen—I am not trying to be disparaging about any of the current systems, but the worst thing that can happen on any retrofit is to have it fail. That tarnishes the whole fuel system.

So you want to do this on a widespread basis with good systems, and we are currently working on that in General Motors.

The CHAIRMAN. Can you bring that cost down?

Mr. COLUCCI. We are hopeful. One of the areas to bring the cost down has been addressed earlier this morning, is with the fuel storage systems. We need lower cost, lighter weight, high-pressure systems for containing the natural gas on board the vehicles.

The CHAIRMAN. How would you recommend that we encourage, or mandate, or help with the move towards CNG?

Mr. COLUCCI. I think you just want to provide the opportunity to the manufacturers and the fuel suppliers. If we know the opportunity is there, we know there are customers that want these vehicles, we will be out there in the marketplace.

The CHAIRMAN. How about Federal procurement?

Mr. COLUCCI. I think that could be addressed, and I do not have the expertise to provide that to you, sir, but I am sure General Motors can and we will follow up with an answer.

The CHAIRMAN. I wish you would, and I wish you would tell us how much of a market you would have to have to get various degrees of confidence level on price breakthroughs on costs.

To me it seems very clear that there ought to, in most areas, be a supply of natural gas and an immediate pay-off from fleet use of those, and I have not looked at if the cost of natural gas goes up a little faster than gasoline, although there is so much dual fuel capacity now for natural gas with crude oil products that I doubt if it will be that huge difference that we had back in the 1970's. But you might comment on that in writing, if you would.

Mr. COLUCCI. We will do so.

The CHAIRMAN. I think there are a number of us who would very much like to encourage that.

One final question, Mr. Colucci. Do buyers of new GM cars need premium gasoline?

Mr. COLUCCI. Very few of them need premium gasoline, sir. Cadillacs for 1990 are designed to operate on premium unleaded gasoline, and some of our other models are designed to operate on either premium or regular, but the bulk of our production is designed to operate on regular, unleaded gasoline, and there are no real reasons why those vehicles cannot be operated on regular, unleaded gasoline.

The CHAIRMAN. Well, where you can do either one, is there any advantage of using premium?

Mr. COLUCCI. With a car with a knock sensor you can get better performance, but you get that better performance at a higher cost of the fuel. It is a trade-off that the owner can make. We do not encourage the use of premium and unleaded gasoline in vehicles designed for regular unleaded gasoline.

The CHAIRMAN. Does it give you more power? Does your car run better, or does it last longer?

Mr. COLUCCI. I do not think it lasts any longer. It may last longer with some gasolines that have higher levels of deposit prevention additives, but you can with a knock sensor-equipped vehicle have higher power and better performance, but again, at the trade-off of a higher-priced fuel.

The CHAIRMAN. That is only with a knock sensor?

Mr. Colucci. With a knock sensor. Without a knock sensor, you do not get anything in terms of performance.

The Chairman. You get nothing?

Mr. Colucci. Right, unless your car is knocking. But our cars are designed not to knock.

The Chairman. Mr. Dickinson, what if refineries who produce reformulated gasoline were to get credit against their stationary source requirements on air toxics? Would that create an incentive to produce reformulated gasoline Nationwide?

Mr. Dickinson. I certainly think it would, yes. We obviously are going to be faced with reduced emissions in all areas, and I think that we should get credit for everything that we can do to reduce emissions into the atmosphere.

The Chairman. Do you think it is a cost-effective pay-off? In other words, the cost of reformulating your refinery as opposed to reformulating the gasoline, do you have a judgment as to where you get the greater pay-off in terms of clean-up per dollar?

Mr. Dickinson. Well, I think the emissions from vehicles are much greater than the emissions from the refineries.

The Chairman. Relative to cost?

Mr. Dickinson. Well, relative to quantity. Relative to cost, the stationary emission sources have been pretty tightly controlled at present, and I believe that there is probably much more to be gained from the vehicle sources than there is from stationary sources at this point in time.

The Chairman. Do you think, Mr. Dickinson, that ETBE should be included in the auto-oil industry research and testing program?

Mr. Dickinson. Well, let me answer the question this way, senator. From our standpoint we are really neutral as to whether we use MTBE or ETBE in our gasoline. ETBE has a slightly better characteristic in terms of octane and lower vapor pressure than MTBE. Our choice would be made strictly on the basis of economics.

The Chairman. I am talking about the testing program now.

Mr. Dickinson. In terms of the testing program, I think that we will learn with MTBE, even if we do not test ETBE, what we need to know with that type of additive in gasoline. I believe ETBE is being considered to be tested in that program, and I think that that is good.

We would certainly support that, but I do not believe it is absolutely necessary to determine the advantages of ether in gasoline, since MTBE and ETBE work pretty much the same in gasoline.

The Chairman. I believe that is all I have. The Senator from North Dakota?

Senator Conrad. Thank you, Mr. Chairman.

As you see it, what are the major hurdles to a more widespread use of ETBE or MTBE? What are the significant hurdles that exist to broadening its use?

Mr. Dickinson. Well, hurdles, basically, are cost benefit. There are clearly some benefits achieved by the use of MTBE or ETBE as an octane-enhancing component for CO reduction in the emissions. There is an added cost when you use those components in gasoline, so you are trading off what the consumer is willing to pay for additional cost of gasoline versus the benefit in the reduced air emissions.

Senator CONRAD. Can you give some feel for what that trade-off is in terms of, what is the additional cost on a per-gallon basis if ETBE is used currently?

Mr. DICKINSON. Well, we are not currently using ETBE, senator, but for MTBE our use in our EC-1 gasoline, it is costing us approximately 2 cents a gallon for MTBE in that gasoline.

Senator CONRAD. What kind of a blend is that?

Mr. DICKINSON. That is present at 5 percent MTBE.

Senator CONRAD. That adds 2 cents a gallon?

Mr. DICKINSON. Yes.

Senator CONRAD. With the benefits of scale, if you were at dramatically higher rates of usage, would that drop, that per gallonage charge?

Mr. DICKINSON. I do not believe so, at this point. You are basically talking about what the cost of MTBE or ETBE would be on the marketplace, and I do not know that we would see significant change in that price. It is I think, for the cost of making it, probably reasonably priced today.

Senator CONRAD. What do you see as the major negative on MTBE or ETBE? What is the major negative that concerns you?

Mr. DICKINSON. I do not believe that we know all there is to know yet about what emissions you get from the combustion of either of those two products.

Our sense is that you do get some formaldehyde produced when you have MTBE or ETBE in the gasoline. Whether or not that will be a significant problem, I think our testing program will disclose those answers.

But that is one concern—that we are reformulating a product to reduce reactive emissions into the atmosphere. If you just replace one reactive component with another reactive component, we really have not gained the objective we are after.

Senator CONRAD. The reason I raise that question is, I have got people in the environmental community who are very concerned that that is exactly what we will be doing. That objection is—raise the formaldehyde is a real concern, and I would just like to get your assessment of how significant that is, and I take it from your answer that it is too early to say.

Mr. DICKINSON. It is from our standpoint and the amount of data that we have, but certainly as the joint auto-oil test program gets underway here and data is developed in that program, we will see what the results of various MTBE gasoline blends produce in terms of exhaust emissions.

Senator CONRAD. Mr. Colucci, would your answers be the same?

Mr. COLUCCI. Yes. One different thing, Senator Conrad: we have to assure that anything we put into gasoline does not adversely affect the performance of the existing 150 or so million vehicles that are out there, and so we have to be very careful that we do not put too much of a good thing into gasoline and make it a bad thing.

So we have to be very careful about raising the concentrations of any specific component in gasoline. We need some assurance, before we do that, that it will not deteriorate materials that are already in the fuel systems in existing vehicles.

Senator CONRAD. Thank you, and thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator Conrad. Gentlemen, thank you very much. We appreciate your testimony.

Next, we have a panel consisting of Mr. George Strang, Vice President, Engineering and Research of Southern California Gas Company in Los Angeles, representing the Natural Gas Vehicle Coalition and the American Gas Association, Mr. Robert Myers, Vice President of Marketing for Petrolane LP-Gas Company of Long Beach, California, representing the National Propane Gas Association and the Gas Processors Association, Mr. Eric Vaughn, President of the Renewable Fuels Association here in Washington, Mr. James Glancey, President of the Clean Fuels Development Coalition in Boise, Idaho, and Mr. Robert Dietch, Vice President for Engineering and Planning and Research of Southern California Edison, Rosemead, California, representing the Electric Vehicle Association.

Gentlemen, welcome to the committee, and we will lead off with Mr. Strang, and I hope you will summarize your testimony.

STATEMENT OF GEORGE STRANG, VICE PRESIDENT, ENGINEERING AND RESEARCH, SOUTHERN CALIFORNIA GAS CO., ON BEHALF OF THE NATURAL GAS VEHICLE COALITION AND THE AMERICAN GAS ASSOCIATION

Mr. STRANG. Thank you, Mr. Chairman. I am George Strang, Vice President, Engineering and Research of Southern California Gas Company in Los Angeles, and as you indicated, appearing on behalf of the American Gas Association and the Natural Gas Coalition—the Natural Gas Vehicle Coalition of AGA.

We believe natural gas represents an opportunity for a safe, economical, energy-efficient solution to mobile source pollution. Natural gas as a motor vehicle fuel is economic and environmentally sound and it is a safe solution.

We believe that strengthening the Clean Air Act will help nonattainment areas reach clean air goals in Los Angeles. There are already strict controls on stationary sources in the city and surrounding areas, and those existing controls result in reduced emissions—as an example, of NO_X—by 70 to 80 percent.

Our view is that those costs currently are approximately $25,000 associated with reduction of a ton of NO_X. Stationery sources are not the major cause of urban air pollution, particularly in our air basin, but legislation is needed to require mobile sources, which in our case contribute over two thirds of the problem, to reduce emissions. This is the only way that we see for air quality improvements to take place, is that the mobile sources need to be lowering their emissions.

Flexible alternate fuel programs for fleets are essential to help reduce harmful pollutants that cause smog. Our best estimates are, those reductions of NO_X could be done for something on the order of $1,200 a ton, with mobile sources emission reductions.

NGVs emit less pollutants than gasoline vehicles. Approximately 85 percent less reactive hydrocarbons, 85 percent less CO, 18 to 30 percent less carbon dioxide.

The NO_x emissions are also below conventional vehicles and we have no evaporative emissions. Emission standards for alternate fuel programs can be an average of an alternate fuel emission or some percentage reduction of the proposed tailpipe emissions, but the issue is that if you have cleaner cars or fewer cars you have less emissions, and we have to recognize that to clean up the air we have to reduce the amount of total emissions and pollutants.

A fleet vehicle mandate is critical to an alternative fuels program in serious and severe ozone and carbon monoxide nonattainment areas. Our industry is designing state-of-the-art engines to achieve top performance on CNG. A number of original equipment manufacturers of engines are participating in those programs.

My company, Southern California Gas Company, and the Gas Research Institute, are spending millions of dollars on CNG technology for light and heavy duty vehicles, but there is still much more to be done.

SoCalGas is involved currently in a joint project with our local rapid transit district and by the summer of 1990 we will have ten CNG operated buses in service using two different engine power plants, about half each.

Those will have a CNG fuel capacity equivalent of 120 gallons of diesel equivalent, so there is a enough fuel storage on those vehicles—those transit buses—to give them the same range they would have had previously with diesel fuel.

We support legislation requiring urban buses to use alternative fuels, and these provisions are in various congressional bills. The Cummins Engine Company has dedicated natural gas engines and will manufacture natural gas engines by 1991. These essentially replace current diesel plant systems.

Mr. Chairman, we need congressional support for alternative fuels programs for enhanced R&D funding, and we believe the natural gas industry stands and offers some of the best solutions to improve our air quality from those mobile sources.

Thank you. I would be happy to answer questions.

[The prepared statement of Mr. Strang follows:]

WRITTEN TESTIMONY OF
GEORGE STRANG
VICE PRESIDENT, ENGINEERING AND RESEARCH
SOUTHERN CALIFORNIA GAS COMPANY
LOS ANGELES, CALIFORNIA
ON BEHALF OF
THE NATURAL GAS VEHICLE COALITION AND
THE AMERICAN GAS ASSOCIATION
BEFORE THE
COMMITTEE ON ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE
ON THE USE OF ALTERNATIVE
FUEL VEHICLES

November 14, 1989

RECOMMENDATIONS

- All clean alternative fuels should participate in an alternative fuel vehicle program. No one alternative fuel should be used to establish an emissions reduction target or as the fuel that is used in the program.
- An emissions reductions target should be established for the overall alternative fuel vehicle program and a separate target should be established for fleet vehicles that are capable of being centrally refueled.
- As part of an alternative fuel vehicle program private and government fleets in serious and severe ozone nonattainment areas should be required to begin using alternative fuel vehicles. The separate emissions reduction target for fleets would ensure that fleet vehicle applications would be the driving force to achieve improvements in technology associated with alternative fuel vehicles.
- Fleet owners required to use alternative fuel vehicles should have discretion to choose the alternative fuel to be used in their fleets.
- Retrofit conversions should be treated as meeting the requirements to use alternative fuel vehicles.
- Regulations should be promulgated to allow on-board vehicle fuel storage cylinders to be tested and retested without removal from the vehicles.
- Diagnostic Inhibit Parts (DIPs) should be required to be manufactured into vehicles. DIPs allow on-board computer systems to be more compatible with a conversion system installed to operate a vehicle on a clean alternative fuel.
- We endorse the provision in the version of S.1630 reported out of the Subcommittee on Environmental Protection that requires certain urban transit buses to begin using alternative fuels in 1991.

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INTRODUCTION

The Natural Gas Vehicle (NGV) Coalition is made up of nearly 100 members, including natural gas distribution companies, pipelines, producers, automotive equipment and vehicle manufacturers, natural gas vehicle users, environmental organizations, educational institutions, and other organizations interested in commercializing natural gas as a vehicle fuel. The NGV Coalition is dedicated to promoting and stimulating the development of a healthy natural gas vehicle industry.

The American Gas Association (A.G.A.) is a national trade association composed of some 250 natural gas distribution and transmission companies.

My company, SoCalGas, and the industry are spending millions of dollars in support of fast-developing technology conducted by the Gas Research Institute aimed at the conversion and development of light-duty and heavy-duty NGVs. Our industry commitment is aimed at producing equipment that can and will meet emissions requirements for mobile sources clean air initiatives.

Several industry members have also entered into a joint project with the Southern California Rapid Transit District (SCRTD). Under the project, the SCRTD is scheduled to put into service 10 natural gas buses.

These natural gas buses will carry 120 diesel gallon equivalents of CNG to give them the same range as regular diesel models. Additionally, each bus will test one of three engines employing various emission reduction technologies. Because the replacement of diesel transit vehicles is an important component of our local air quality management plan, SoCalGas' joint program with the transit district is a critical first step toward proving the effectiveness of heavy-duty fleet NGVs.

Other gas companies have taken similar initiatives. For instance, last September the Columbia Gas Company christened 'Columbia' -- the nation's first bus designed and built exclusively to run on natural gas -- which appeared on Capitol Hill in conjunction with the "On the Hill with Natural Gas" conference. Because natural gas is so clean burning, the bus has no particulate or sulfur emissions -- a white handkerchief held to the bus's tailpipe will show no evidence of soot -- and emissions of nitrogen oxide, carbon monoxide and hydrocarbons are substantially reduced compared to today's diesel buses. Columbia Gas is convinced that use of natural gas buses can mean the end to buses that spew black soot. A.G.A. and the NGV Coalition are very encouraged by the strong interest by many federal, state and local officials as well as transit authorities in the 'Columbia.'

In August of 1988, the Department of Energy released "Progress Report Two: The International Experience" as the second volume of its multi-volume study, Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector.

This DOE study surveyed the actual experience with alternative-fuel vehicles in several different countries that are pioneers in the field.

The DOE study shows that, of all the alternative-fuel vehicles being used throughout the world, more than half are running on gaseous energy.

Our testimony will show that this is no accident. Natural gas vehicles offer a wide range of benefits for their customers and for the public in general. It is no wonder they are popular.

Natural gas vehicles can be popular in this country, too -- *if* public policy decision-makers will include them in air quality planning *and* permit them to compete on their own merits against other alternative-fuel vehicles. It is against this backdrop that our testimony focuses first on our recommendations concerning S. 1630 and the improvements we believe necessary to achieve its laudable environmental goals. Then, we will expand upon the many environmental advantages offered by natural gas vehicles and the role NGVs can play in an aggressive federal alternative fuels program.

AIR QUALITY BENEFITS OF NGVs

EPA Estimates of Emission Reductions From NGVs

On January 28, 1988, the Environmental Protection Agency issued a Technical Guidance Document, suitable for use by state and local governments in estimating the actual impact of various air quality improvement options. The document, entitled Technical Report: Guidance on Estimating Motor Vehicle Emissions From the Use of Alternative Fuels and Fuel Blends, estimates that NGVs can yield the following emission reductions:

-A 50% reduction in tailpipe emissions of carbon monoxide;

-A 40% reduction in tailpipe emissions of reactive hydrocarbons;

-A 100% reduction in emissions of reactive hydrocarbons from filling stations and evaporation.

We note that EPA views its estimates as advisory rather than mandatory. That is, EPA permits states and localities to use their own estimates, in place of EPA estimates, where states and localities can show it is reasonable to do so. This point is particularly important because, in the gas industry's view, EPA has been conservative in estimating the achievable emission reductions from shifts to NGVs.

We regard EPA's estimates as conservative. Our estimates, based on gas industry experience, show that even more dramatic reductions are achievable for carbon monoxide and reactive hydrocarbons. As compared to gasoline vehicles, natural gas vehicles offer major reductions in emissions of carbon monoxide and reactive hydrocarbons.

So far, nearly all natural gas vehicles on the road in the U.S. are conversions of existing vehicles that once relied solely on gasoline or diesel fuel. Our experience with such vehicles indicates that, when proper procedures are used to convert older gasoline or diesel fuel vehicles to natural gas, such conversions can reduce emissions of carbon monoxide and reactive hydrocarbons by more than 80 percent.

The actual emission reductions achieved depend on a large number of factors, including the tuning of both engines, the age and design of both vehicles and the condition and technology of the gasoline emission controls and the natural gas conversion equipment. Despite these possible variations, however, the emission reductions will be significant so long as proper procedures and equipment are employed.

Even compared to vehicles that employ new gasoline technology, NGVs can achieve significant reductions of emissions. We estimate that carbon monoxide could be

Even compared to vehicles that employ new gasoline technology, NGVs can achieve significant reductions of emissions. We estimate that carbon monoxide could be reduced by up to 82 percent and reactive hydrocarbons -- those that contribute to ozone pollution -- could be reduced by up to 87 percent even in the case of new vehicles that have suffered no degradation from exposure to road conditions.

Because new gasoline vehicles have made substantial headway in reducing gasoline-related nitrogen oxide, out-performing gasoline vehicles with respect to this pollutant is a difficult challenge. However, it appears that newly manufactured engines that are designed from the start for natural gas, whether this involves "dedicated use of natural gas" or "dual capability", can be engineered to prevent any nitrogen oxide problem before it begins.

In a study recently prepared for A.G.A.,[*] Professor E. J. Durbin of Princeton University concludes that an engine designed to run on natural gas could achieve reductions of nitrogen oxides by virtue of the cleaner air/fuel mixtures that would be possible with such an engine. These emissions reductions could be achieved without the use of a catalytic convertor, thereby maintaining low emission levels that could not be maintained over time by a catalytic convertor.

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[*] Durbin, E.J., Understanding Emissions Levels from Vehicle Engines Fueled with Gaseous Fuels; Princeton, N.J.; Princeton University, February 1989.

The efficiency of a catalytic convertor decreases rapidly with time as the catalyst becomes poisoned with exhaust products.

A list of Professor Durbin's conclusions on fueling vehicles with natural gas is as follows:

1. This study has shown that from both emissions and efficiency points of view, gaseous fuels, and in particular natural gas fuels, are superior to gasoline in vehicular applications. The engine designer would prefer natural gas as a fuel over any other fuel.

2. Principal advantages of natural gas fuels come from the ability to create homogeneous mixtures of air and fuel more readily, which permits the use of lean combustible mixtures, and from the low carbon hydrogen ratio of fuel molecules.

3. Most assessments of emissions with natural gas fuels are based on fuel systems that have not been optimized for natural gas. These systems do not exploit the full advantages of natural gas fuels.

4. In an engine "designed for natural gas" it should be possible to achieve oxides of nitrogen emissions much lower than those emissions from gasoline engines.

5. These low emissions should be attainable without catalytic convertors to clean up the engine exhaust.

6. Total hydrocarbons can be reduced 33 to 50 percent when using gaseous fuels. When the gaseous fuel is natural gas, environmentally active hydrocarbons can be reduced 90 percent as compared with gasoline.

7. With lean mixture control systems, carbon monoxide can be effectively eliminated from the exhaust of natural gas fueled engines.

8. Carbon dioxide emissions are reduced approximately one third as compared with gasoline.

9. An essential element in achieving these results, with good driveability, is a control system which adjusts air/fuel ratio to fit power requirements. Such a control system, coincidentally, provides increased fuel economy.

Of course, while newly manufactured NGVs can be expected to out perform retrofitted NGVs in emission levels and other respects, retrofitted NGVs are still the key to any immediate improvement in pollution from carbon monoxide and reactive hydrocarbons. NGV retrofitting is the only way that we can put large numbers of alternative-fuel vehicles on the road within the next few years.

After this discussion, it may be useful to summarize our emission reduction estimates in capsule form. Table I summarizes the emission reduction estimates for retrofitted vehicles.

TABLE I

A.G.A. ESTIMATES OF ACHIEVABLE EMISSION REDUCTIONS PER VEHICLE WHEN GASOLINE VEHICLES ARE RETROFITTED TO NATURAL GAS*

Pollutant	Vehicles Using Older Gasoline Technology	Vehicles Using New Gasoline Technology
CARBON MONOXIDE	-99%	-82%
REACTIVE HYDROCARBONS	-92%	-87%

* Assumes use of proper procedures and equipment.

Use of Natural Gas in Heavy Duty Engines

Newly manufactured heavy duty trucks and buses must soon meet tightened EPA standards for heavy duty engines. Newly manufactured natural gas engines are an extremely attractive compliance option.

This year, Flxible Corp. conducted laboratory tests on the nation's first transit bus designed and built to run exclusively on natural gas. The tests showed that a natural gas bus engine equipped with a catalytic converter is capable of meet thing 1991 EPA emission standards for diesel transit buses.

In 1988, newly manufactured natural gas buses, leased to the City of New York by Brooklyn Union Gas Company, were tested by EPA at the EPA facilities in Ann Arbor, Michigan. The results of these tests show that emissions from the buses met, or far surpassed, the EPA standards for model year 1991 gasoline-fueled heavy-duty engines.

For carbon monoxide, emissions were 10.6 grams per brake horsepower-hour (g/b-hp/hr), compared to a standard of 14.4.

For nitrogen oxide, emissions were 1.4 g/b-hp/hr, compared to a standard of 5.0.

For reactive hydrocarbons, which were only about 15% of the total hydrocarbons emitted, the bus emissions were extremely low. Even for total hydrocarbons, most of which do not appear to react chemically in the low atmosphere, the bus emissions were 1.2 g/b-hp/hr. The standard is 1.3.

Greenhouse Effect Considerations

Given the rising interest in possible global warming consequences from an apparent greenhouse effect, any environmental policies should take into account the estimated direct and indirect carbon dioxide emissions from vehicular combustion of natural gas, gasoline, gas-derived methanol, coal-derived methanol and other fuels.

Carbon dioxide is thought to be the leading actor in the greenhouse effect. With this concern in mind, we cite a recent Congressional Research Service Report for Congress entitled Carbon Dioxide Emissions From Methanol As A Vehicular Fuel. This Congressional Research Service report provides somewhat different numbers from those provided in an earlier World Resources Institute study. However, both studies agree on two key points: (1) use of coal-derived methanol in vehicles will substantially increase carbon dioxide emissions; and (2) direct combustion of natural gas in vehicles will substantially decrease such emissions.

The report estimates that, in comparison to gasoline, direct combustion of natural gas in vehicles will reduce carbon dioxide emissions by 30% or more.

Natural gas vehicles do emit some unburned methane. In fact, unburned methane accounts for most of the non-reactive hydrocarbons emitted by NGVs. As the term "non-reactive hydrocarbon" suggests, unburned methane is not a chemically interactive gas and does not contribute to smog formation. We are aware of speculation that unburned methane from natural gas vehicle tailpipes, while not chemically reactive in the lower atmosphere, may nevertheless pose environmental problems in the upper atmosphere because methane is a "greenhouse gas". The Congressional Research Service has concluded that methane emissions from NGVs would be so miniscule that, even if every vehicle in the world were to run on natural gas, the total additional emissions of methane would add only about 0.1% to the current methane emissions from all sources.* In fact, we believe, given our research on the issue, that NGVs reduce total vehicular greenhouse impacts by at least 25 percent even when considering methane emissions.

State Actions

In recognition of the air quality improvements that NGVs or other alternative fuel vehicles can make, states such as Texas, Arizona, and California have adopted measures to promote these vehicles. Pennsylvania and New York are currently considering such initiatives.

The most recent example of ambitious state action in this regard occurred in California where the Governor signed legislation early this month that mandates that at least 25 percent of new state vehicles must run on clean alternative fuels and that the state sales tax will not be imposed on the incremental cost of clean-fuel vehicles.

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*Gushee, David E., "Alternative Fuels for Motor Vehicles, Some Environmental Issues," (Washington, D.C.: Congressional Research Service, 1988), pp. 17-18.

In Texas the state legislature passed a bill on May 29, 1989 to promote NGVs and other clean vehicles. The Texas legislation requires phased-in vehicle conversions to NGVs or other clean vehicles starting in 1991. State-owned or operated fleets with more than 15 vehicles, school districts with more than 50 buses, and local transit authorities must convert their fleets to NGVs starting in 1991 and finishing in 1998. The legislation anticipates private financing for the vehicle conversions but allows for waivers in instances were reasonable financing is unavailable.

ECONOMIC BENEFITS OF NGVs

In addition to the obvious environmental benefits of natural gas, it may also be the most economical of all alternative fuels currently available. The cost of fueling a vehicle with natural gas is currently estimated to be about 30% - 60% of the cost of fueling a vehicle with gasoline, including the additional cost of compressing the natural gas. The price per gallon equivalent of natural gas currently ranges from 40 to 75 cents. While the pump price of natural gas varies from region to region, much like gasoline, the typical sale price of natural gas averages approximately 62 cents per equivalent gallon. Furthermore, it should be pointed out that several gas companies, including A.G.A. and NGV Coalition member Pacific Gas and

Electric Company, are developing a low pressure natural gas storage system that will significantly lower the overall cost of natural gas as a vehicle fuel by obviating the need for compression.

In addition to natural gas' lower pump price, and because of its clean burning qualities, natural gas offers significant savings in vehicle maintenance costs. Practical, on-road experience with natural gas vehicles shows that standard maintenance is half that of gasoline powered vehicles. Many users report that oil changes need not occur more than every 10-20,000 miles, and spark plugs, points and other components have lasted up to 75,000 miles in some vehicles.

SAFETY

Unlike many other alternative fuels currently under development, natural gas has a long and rich history as a vehicle fuel dating back to the infancy of the automobile itself. There are currently over 500,000 natural gas fueled vehicles worldwide, including over 30,000 in the United States. The lesson we have learned from this long history and extensive use is that natural gas may be the safest vehicle fuel of any type currently available, including gasoline.

A recent A.G.A. survey of natural gas vehicle fleet operators revealed that in over 434.1 million miles driven by the sample fleet, injury rates per vehicle mile traveled were 84% less than the national average for injuries per vehicle mile traveled for all U.S. registered vehicles.

The vehicle miles travelled by NGVs were small by comparison with gasoline vehicles, but nevertheless, the injuries reported were far less than those that would be expected statistically for gasoline vehicles.

In addition, the unique properties of natural gas itself make it extremely safe for use as a vehicle fuel. Unlike some other alternative fuels, natural gas is neither corrosive nor toxic. Natural gas is lighter than air. Therefore, in the unlikely event of a leak, natural gas will safely dissipate into the air. Gasoline and some other liquid alternative fuels form dangerous puddles and pools on the ground in the event of a leak. Moreover, natural gas' ignition point is two times higher than that of gasoline, only igniting at a temperature of between 1200 to 1300 degrees, and only within a very narrow gas-to-oxygen mixture range of 5 to 15 percent.

Finally, the fuel tank cylinders for natural gas vehicles may be the safest and most extensively tested vehicle fuel storage system available. They are typically made of reinforced aluminum or three-quarter-inch-thick steel and have been subjected to severe abuse testing.

Natural gas cylinders have successfully withstood blasting with dynamite, freezing, bonfires, and bullets, all without bursting or causing fire. None of the other alternative fuels, with the exception of, perhaps, propane, can make this claim.

NATIONAL SECURITY BENEFITS OF NGVS

America's reliance on imported oil is on the rise again. At this point, foreign sources meet approximately 50 percent of the oil we consume every year -- and many of these foreign supplies come from OPEC countries. The need for transportation fuel plays a strategic role in our nation's inability to break free.

Since the internal combustion engine was invented, oil has held a virtual monopoly in the transportation fuels market. In every other major energy use market -- from chemicals to powerplants -- substitutes for oil are readily available and can be mobilized for use in the event of another disruption of imported oil supplies. In transportation, however, oil still reigns supreme.

To grasp the extent and implications of this oil dominance, consider the fact that transportation absorbs two-thirds of all the oil we use in America. If tomorrow we stopped using oil for everything else -- for heating homes, for making chemicals, for generating power -- we would still have to import oil just to feed our transportation sector.

Clearly, America will not be able to end its vulnerability to imported oil disruptions until America introduces competition in the transportation fuel market.

Natural gas also has the benefit of a delivery system of over one million miles of existing pipeline. Through this pipeline network, natural gas can be brought to virtually any part of the nation for vehicular transportation.

AVAILABILITY OF NGV TECHNOLOGY

As previously stated, there is a long and rich history of the use of natural gas as a vehicular fuel. Of the 500,000 natural gas vehicles operating worldwide, Italy has almost 300,000 such vehicles on the road today. Other countries, such as Canada, New Zealand, and China, have extensive experience with natural gas as a vehicle fuel and large operating fleets of such vehicles. The Soviet Union has recently announced its plan to convert one million of its vehicles to clean-burning natural gas. In the U.S., we currently have approximately 30,000 natural gas vehicles on the road and operating. These vehicles range from heavy duty buses, trucks, and delivery vans to personal family cars. While there is a high degree of reliability and safety associated with natural gas vehicle technology, the natural gas vehicle industry is continuing to develop and improve its equipment.

For example, the Ford Motor Company built 27 Ford

Ranger pickup trucks which were designed and built from the ground up to run on natural gas. GSM Taxi is currently producing a line of long-life vehicles suitable for use as taxis or work vans that are designed to run exclusively on natural gas. Member companies of A.G.A. and the NGV Coalition have made a commitment to purchase more than 20 of these vehicles for use as service vans in their fleets. Brooklyn Union is presently testing them on the streets of Brooklyn to assess their potential for use in the New York City market as service vans or as long-life taxis, something that New York, and many other cities for that matter, could desperately use.

For general vehicle use, there is currently a highly developed state of the art engine technology for light duty applications on vehicles weighing less than 8,000 pounds. Conversion equipment is the most common application for both carbureted and fuel injection engines. The various equipment packages now on the market allow the conversion of existing engines either to run exclusively on natural gas or to be dual fuel capable, which allows the driver to run on either natural gas or gasoline.

The conversion equipment for carbureted engines can be installed on most gasoline engine currently on the market. Conversion kits for fuel injected engines are also available. In fact, because of the more efficient mixing of fuel and air, fuel injection conversions are preferable.

There is also an extensive amount of work being performed in the development of heavy duty engine technology for vehicles weighing more than 8,000 pounds. Retrofit equipment for diesel engines is available that allows diesel engines to run on a mixture of approximately 80% natural gas and 20% diesel fuel. This mixture greatly reduces the heavy particulate emissions produced by heavy duty diesel engines, as well as substantially reducing other harmful emissions. Southwest Gas Corporation has assisted the City of Phoenix, Arizona in retrofitting one of its transit buses with such equipment, kit, and that bus is currently in operation in that city.

Diesel engines specially designed and engineered to run exclusively on natural gas are also currently under development. We believe that such dedicated diesel-derived engines running on natural gas will be the accepted standard for heavy duty engines in the near future as they will allow heavy duty diesel engines to meet the EPA's upcoming diesel emission standards.

The Gas Research Institute has allocated a total of $11 million through 1992 to developing this and other natural gas vehicle technology. Cummins Engine Company has joined forces with the Gas Research Institute to develop a low emission heavy duty natural gas engine and has delivered the first of these engines to transit bus manufacturers. Cummins has indicated that it will produce 100-200 of these engines in 1990 and enough engines to meet demand in 1991. All of these engines will meet the tough emission standards applicable to model year 1991. Also, Hercules Engine has announced its plan to develop and commercialize two dedicated natural gas fueled diesel-derived engine to market this year. Southwest Research Institute is developing conversion equipment which will allow existing diesel engines to be converted to run on natural gas.

Several programs involving mass transit buses are actively underway. The most recent is a project co-funded by Columbia Gas and Southern California Gas Company which has resulted in the nation's first transit bus designed and built to run exclusively on natural gas. The program, which was managed by Columbia Gas, was designed with natural gas in mind for every feature of the bus. The approach and analysis of the overall system was the responsibility of Flxible Corp., which manufactures about half the transit buses in the U.S. The engine, built by Cummins Engine Co., is a natural gas version of the Cummins L10 diesel engine which is commonly used in transit buses. The on-board compressed natural gas tanks, produced by Comdyne I Inc., are special tanks that consist of an aluminum shell wrapped with fiberglass.

The bus has the same operating range, fueling cost and long-term durability of a diesel bus -- but with much lower emissions and pollutants.

The first bus off the assembly line, which was introduced September 8, has been displayed in Washington, D.C. and other major cities. Within the next few weeks, it will go into revenue service in Columbus, Ohio, as part of the Central Ohio Transit Authority's fleet.

The successful potential of heavy duty natural gas engine technology is being tested in Los Angeles. As noted previously, the SCRTD will put 10 natural gas buses into service in its operating territory. The program also involves the conversion of two diesel buses to run on a mixture of diesel and natural gas. Southwest Research Institute is providing some of the technology for the conversion with funding from Southern California Gas Company.

Brooklyn Union is currently testing two natural gas buses in daily service in New York City. The buses were manufactured by Bus Industries of America using GM 454 engines that were converted to run exclusively on natural gas. As noted previously, the buses have been through extensive emission testing by the EPA at its testing lab in Ann Arbor, Michigan and have achieved excellent results. Furthermore, last summer, Brooklyn Union drove one of its natural gas buses from New York City to the World Gas Conference in Washington, D.C. and back without any difficulty or problems.

Brooklyn Union has also initiated a program with United

Parcel Service (UPS). In that program, UPS had placed in service 10 NGV step vans as part of its normal operating fleet in New York City.

GAS SUPPLY AVAILABILITY FOR NGVS

There are clear environmental reasons to expand vehicular use of natural gas. There are no supply-related reasons to hold back.

So long as the domestic natural gas resource base remains free of price controls and other artificial market constraints, the domestic resource base -- particularly when it is coupled with supplemental North American gas sources in Canada and Mexico -- is large enough to meet substantially higher levels of gas demand. The resource base is also large enough to overcome the results of occasional marketplace misjudgments.

Recent Estimates of the Natural Gas Resource Base

The domestic natural gas resource base is huge. In March of 1987, in a volume entitled Energy Security: A Report to the President of the United States, DOE told President Reagan:

> If unconventional gas supplies (such as gas shales, tight sands gas, and gas hydrates) are included in the total, the Nation's supplies of natural gas may support 200 years of consumption at current rates.

In May of 1988, DOE issued a landmark study on natural gas supplies, entitled An Assessment of the Natural Gas

Resource Base of the United States. In this study, which drew upon the knowledge of a number of expert panelists, DOE focused solely on natural gas resources that are domestically available and can be recovered with today's technology. The study found that, in the lower 48 states alone, natural gas reserves and resources total 1,059 trillion cubic feet (Tcf). At the 1987 level of nationwide gas consumption, this amount is equivalent to a 62-year supply.

Of this 62-year supply of technologically recoverable gas, the equivalent of a 35-year supply is available at wellhead prices below $3.00 per million Btus (MMBtu). This wellhead price range is not too different from prices that now occur at the peak of the winter heating season.

DOE adds that the 35-year supply can rise to a 45-year supply if wellhead prices rise to $5.00 per MMBtu. This range is far above today's prices, but still within the historical experience of gas consumers in the early 1980s. These supply figures do not include vast natural gas resources in Alaska (estimated by DOE at 129 Tcf), Canada and Mexico.

In short, DOE's estimates of the gas that is ultimately available to American consumers can be considered conservative. We add that DOE's resource base estimates are similar to the most recent estimates made by the Potential Gas Committee (PGC), a body of independent experts from throughout the natural gas industry. According to the latest PGC study, in the lower 48 states alone, conventionally recoverable gas at year-end 1988 (including "proven" reserves, which are already known to exist) was 836 Tcf. At 1987 gas consumption rates of roughly 17 Tcf per year, the PGC estimate is equivalent to a 49-year supply. Using either the DOE or the PGC supply estimates, it is clear that the lower 48 states are able to produce enough natural gas to meet expanded gas demand.

An "Elastic" Resource Base

In a December 16, 1988 letter that invited A.G.A. to testify at the field hearings of the Health and Environment Subcommittee of the House Energy and Commerce Committee, Chairman Henry Waxman (D-CA) asked A.G.A. this question:

> In the context of both methanol and compressed natural gas, how much of the existing motor vehicle fleet in California and nationally could be powered for how long by currently known natural gas supplies?

This question highlighted the fact that the domestic supply of natural gas is an elastic resource base. A.G.A. responded to the question by pointing out that, for a given number of vehicles, the volumes of natural gas required to fuel the vehicles indirectly -- through conversion of the natural gas to methanol -- will be more than 50 percent greater than the volumes required to fuel the vehicles directly. This is because more than one-third of the original energy content of natural gas is typically lost during the gas-to-methanol conversion process.

Beyond this response, it is important to note that a fixed natural gas inventory does not, in fact, exist. What exists instead is an "elastic" resource base: one that expands in response to the marketplace incentives of price level and demand level.

The lesson of an "elastic" resource base has become clear to the gas industry over the last 20 years. During the 1970s, prior to the enactment of the Natural Gas Policy Act of 1978, reserve replacements as a percentage of domestic production averaged 46 percent. During the 1980-88 period the reserve replacement ratio has averaged 89 percent.

During the late 1970s and early 1980s, surging wellhead prices brought forth pioneering development of frontier gas resources -- including deep gas, tight sands gas and gas from deep waters offshore. Some frontier gas volumes became accessible as a direct result of the higher wellhead prices, while other volumes became accessible as a result of new technology induced by the higher wellhead prices. In any case, America's gas "inventory" was shown to be fluid instead of fixed.

In a variation on this theme, the subsequent drop in wellhead prices also expanded the scope of potentially accessible resources. Just as higher wellhead prices developed technology and expertise for reaching deep onshore and deep offshore gas, so lower wellhead prices induced more efficient drilling practices and development of lower-cost technology for tapping more gas from conventional onshore reservoirs. Once again, the resource base was shown to be "elastic".

Thus, we cannot say "how long" the nation's gas supplies will "last" if natural gas serves as a transportation fuel on a major scale. We can report, with recent history as our guide, that the domestic resource base will tend to grow as the nation's need to rely on it grows.

An Important New Study of Future Gas Supply and Demand

A November 1988 report, prepared by two former high-ranking DOE officials, concludes that the nation could increase its natural gas consumption by a substantial amount without triggering any disruptive distortions of the energy marketplace.

The study in question, issued by Washington Policy and Analysis, is entitled Natural Gas: A Strategic Resource For the Future. The two authors are William Martin and Scott Campbell, both of whom served as high-level DOE officials in the Reagan Administration.

One major focus of the study is possible change in overall gas supply and demand between 1987 and 2010.

Among other findings, the study concludes that, under an appropriate mix of low-cost public policy initiatives that are consciously designed to foster the increased use of natural gas, nationwide gas consumption could rise from the 1987 level of 17.1 Tcf to a new level of 24.1 Tcf in 2010. The study indicates that this major increase could occur without causing significant marketplace distortions, and the study explicitly addresses the question of how the necessary gas supplies can be obtained.

Apart from its substantive findings, the study is also historically significant for its methodology. The study is likely to represent a milestone in energy modeling because it provides the first independent analysis of the implications resulting from end-use technology developments and recent work in the area of gas resource base estimates.

POSSIBLE IMPACT OF NGVS ON OVERALL GAS DEMAND

We have attempted to develop, for purposes of gaining perspective on domestic energy security, some estimate of how large-scale use of NGVs might affect gas demand.

Our analytical task has been complicated by the fact that America has placed on the road a great mix of vehicles, with a great diversity in fuel consumption patterns that reflects differences in engine type as well as major jumps in energy efficiency as we move from one "vehicle vintage" to another.

Table II indicates the diverse range of possible gas demand per vehicle, just among light duty vehicles.

Table II
ESTIMATED NATURAL GAS DEMAND PER VEHICLE PER YEAR*
In thousands of cubic feet (Mcf)

Type of Vehicle	Estimated Annual Gas Demand*
Old "Vintage" Passenger Car	100
Brand New Passenger Car	50
Average for All Passenger Cars, Old and New, On the Road in 1985	64**
Average for ALL LIGHT DUTY VEHICLES, Old and New, Including Light Duty Trucks, On the Road in 1985	76**

*Assumes exclusive use of natural gas.
**Derived from Department of Transportation data.

We estimate that if eight to ten million vehicles in the United States were converted to natural gas, they would only use approximately one trillion cubic feet of gas, or roughly six percent of our total annual consumption.

Since newly acquired diesel-fueled buses must soon meet EPA's 1991 emission standards for heavy-duty diesel engines, the Committee may be interested in an estimate of fuel consumption by natural gas buses. Although we do not have these data for municipal buses, we can use data held by the Department of Energy concerning fuel consumption by commercial buses in general, including intercity buses. Using these data as a starting point, we can offer a "ballpark" estimate that the average municipal bus, if using natural gas exclusively, would consume 860 Mcf per year.

While this consumption per vehicle is relatively high, the number of buses in America is relatively small. Almost 20,000 natural gas buses that use only natural gas would have to placed in service before the increment of added gas consumption would reach one-tenth of 1% of the national gas consumption in 1987.

The Washington Policy and Analysis study referenced previously, Natural Gas: A Strategic Resource for the Future, provides a national perspective on possible gas demand for NGVs. The study speculates that, with low-cost but supportive public policies and vigorous efforts by the gas industry, natural gas could attain the following market shares by 2010:

-5% of the mass market for passenger vehicles

-25% of the market for public and private fleet vehicles (excluding military vehicles)

-75% oi the market for commercial buses

These are reasonably ambitious market penetration goals for the natural gas industry. Yet the study concludes that, even if these goals were reached, gas demand for NGVs would be 1.7 Tcf per year, a very manageable amount of gas. This is roughly 10% of the actual nationwide gas consumption in 1987.

CONCLUSION

The NGV Coalition and A.G.A. believe that an effective program to amend the Clean Air Act must include a provision that encourages the use of alternative fuels. Emissions from vehicles represent approximately half of the air pollution problems -- or more than half in some cases -- that currently plague some of our urban areas. Alternative fuels could contribute significant improvements in air quality in a relatively short time frame. For that reason, we would endorse an ambitious alternative fuels program that includes our recommendations in S. 1630.

The CHAIRMAN. Thank you very much, Mr. Strang.
Mr. Myers?

STATEMENT OF ROBERT MYERS, VICE PRESIDENT, MARKETING, PETROLANE LP-GAS CO., ON BEHALF OF THE NATIONAL PROPANE GAS ASSOCIATION AND THE GAS PROCESSORS ASSOCIATION

Mr. MYERS. Thank you, Mr. Chairman. I am Bob Myers with Petrolane in Long Beach, California. I am here representing the National Propane Gas Association and its 4,000 members as well as the Gas Processors Association, representing its 186 members who produce 90 percent of the Nation's natural gas liquids and over 750 operating plants.

As was stated earlier here in previous testimony this morning, LPG is the most widely-used alternative motor fuel in the world and the United States. We estimate between 2½ and 3 million vehicles are running on it throughout the world. In the United States, 330,000 highway vehicles, plus several hundred thousand nonroad vehicles are using LPG.

LPG consists primarily of butane and propane and is derived from the processing of natural gas and refining of crude oil. Approximately 88 percent of the supply is domestically produced here in the United States with 75 percent of the imports coming from Canada. It therefore is a very secure energy source.

Supply was a concern of the Committee this morning. Let me address the issue of supply of LPGs. In 1987, the United States produced about—nearly 19 billion gallons of LP gases, of which 12.6 was propane. This is used in a variety of uses—chemical, agricultural, domestic heating, et cetera.

Our future supplies of LP gas will be enhanced with additional butanes as a result of the lowering of the vapor pressures of gasoline. Sixty-five percent of all the butane used in the United States currently goes into gasoline blending.

However, today butane is being exported from both the East and the West Coast of the United States to Latin America and the Caribbean, and based on the current governmental policy, this country's short-term and mid-term alternative fuel strategy appears to be to import methanol at the same time we are exporting domestically-produced gas liquids.

Looking at the question of adequate supply, we estimate an additional 4 billion gallons of U.S.-produced supply will be available by the year 2004. If we throw in the Canadian surplus production and only 50 percent of the other world-wide surplus, we calculate another 8 billion gallons will be available during the next 15 years.

Then if we add the gas liquid planned for export off of the Alaska North Slope, the additional supply grows to 11 billion and this does not include the 5.3 billion gallons that currently is being used in the chemical market here in the United States.

In summary, the current and projected supply is more than adequate to operate a minimum of 6.5 million vehicles on LPG. By adding the Alaska North Slope we estimate 8 to 10 million is a reasonable expectation of vehicles that could be running on LP gas sometime between now and the end of the century.

Relating that to a market, statistics indicate that there is a total of U.S. truck registration of almost 19 million vehicles and of this approximately 8½ million are in fleet use. We believe that LP gas and natural gas are particularly suited for the market characterized as fleets, which return to a central base every night and which consist of vehicles that are five years old or less.

Natural gas, as well as LP gas, has shown tremendous consumer acceptance, as is indicated here this morning. In addition to the vehicles running in the United States there are 160,000 operating in Canada, utilizing over 4,000 refueling stations; in the Netherlands 450,000, which really represents almost 17 percent of the entire vehicle population in the Netherlands.

There is no particular limitation on the size or the kind of vehicle that can use LP gas, other than the diesel cycle engines. It is used as both a dual fuel and dedicated fuel vehicle. The greatest emission reductions, however, can be achieved from the dedicated vehicles.

Like natural gas, LP gas offers the advantage of cost savings over gasoline and methanol, especially when purchased in bulk for fleet use. A second benefit is that engines running on LPG last longer and require less maintenance.

The subject of emissions was covered here by the EPA this morning and I will not go into that.

One area of concern seems to be cost of the fuel as well as conversions. Just a brief comment. Vehicles can be manufactured to run on LP gas or existing gasoline vehicles can be converted. Ford currently manufactures a straight propane-powered medium duty truck.

Both Ford and Chrysler produced propane-powered cars in the early '80s. Conversion costs are usually in the range of $1,000 to $1,500 per vehicle. Pay-back costs come in reduced fuel cost and lower maintenance, and it usually takes two to three years to get an adequate pay-back.

An LP gas vehicles cost-per-mile is normally 25 to 35 percent lower than gasoline. In small quantities the cost per gallon ranges from nearly equal to gasoline, to a savings of 40 percent. In larger fleets purchasing LP gas fuel, savings of 20 to 55 percent are realized.

In conclusion, Mr. Chairman, we continue to believe there is no one alternative fuel that will provide a panacea for clean air problems or for energy security. The United States should diversify its motor vehicle fuel dependency. NPGA and GPA support the inclusion of a balanced alternative fuel provision in clean air legislation.

Public policy stands on firm ground when it makes choices among proven options. By creating a level playing field, market-proven fuels such as LP gas and CNG will develop quickly, while unproven fuels such as methanol can continue to develop. We believe that LPG will continue to serve as a secure and environmentally beneficial alternative fuel.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Myers follows:]

NPGA
National PROPANE GAS Association
1235 Jefferson Davis Highway • Arlington, Virginia 22202 • 703/979-3560

November 14, 1989

TESTIMONY OF THE NATIONAL PROPANE GAS ASSOCIATION AND THE GAS PROCESSORS ASSOCIATION BEFORE THE SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES ON ALTERNATIVE MOTOR FUELS

Mr. Chairman, I am Robert Myers, Vice-President of Marketing at Petrolane LP-Gas Company. This morning I am representing the National Propane Gas Association and the Gas Processors Association. I am pleased to offer our views on alternative fuels and clean air legislation.

The National Propane Gas Association (NPGA) represents over 4,000 members in all 50 states who comprise all aspects of the LP-gas industry including marketers, suppliers, transporters, producers and equipment manufacturers.

The Gas Processors Association (GPA) represents 186 member companies who produce 90% of the nation's natural gas liquids at over 750 operating plants. The U.S. gas processing industry is a major segment of the oil and gas industry, distinct from either crude oil or natural gas production, separate from crude oil refining or gas distribution, yet indispensable to all.

Liquefied Petroleum Gas (LP-Gas) is the most widely used alternative motor fuel in the world and in the United States. We estimate that between 2.5 and 3 million vehicles run on LP-Gas. In this country over 330,000 highway vehicles use LP-Gas and several hundred thousand other non-road vehicles and stationary engines use LP-Gas.

We know from experience that LP-Gas offers a cost effective approach to reducing air pollution and to diversifying our motor fuel sources. LP-Gas consist primarily of propane and butane and is derived from the processing of natural gas and the refining of crude oil. Approximately 88% of supply is domestically produced with 75% of the imports coming in from Canada. It is therefore a secure energy source.

We support the inclusion of a substantial alternative fuels provision in revisions to the Clean Air Act. We believe that the legislation should be neutral in regards to choice of fuels and that the decision of which fuel to use can best be determined in the marketplace. Given that severe pollution problems currently exist in many cities and the likelihood that pollution will become worse, alternative fuels will play a role in reducing automotive pollution.

The two goals of energy security and reduced emissions must be met by any alternative fuel. We believe that past experience with energy controls leads to the conclusion that the Federal government or the Federal government in consultation with any interest group ought not to determine an alternative fuel of choice.

SUPPLY AND MARKETS SERVED

According to the Energy Information Administration, in 1987 the U.S. produced about 18.9 billion gallons of LP-gases of which 12.6 gallons were propane, the rest being largely butane and isobutane. In 1987, LP-gas use consisted of 35.2% commercial and residential heating, 39% chemical use, 9% farm use, 8% industrial, 2.8% automotive and 1.7% other engine fuels.

Future supplies of LP-Gas will be enhanced with additional butanes as a result of the lowering of vapor pressures of gasoline. Ninety-five percent of all butane used in the U.S. currently goes into gasoline blending. Lower vapor pressure will preclude much of the use of butane today. Today, butane is being exported from both the East and West coast to Latin America and the Caribbean. We believe that this is unconscionable, considering the pollution problems facing this country. This country's short to mid-term alternative fuel strategy is to import methanol at the same time we are exporting domestically produced gas liquids.

Looking at the question of adequate supply, we estimate that an additional 4.0 billion gallons of U.S. produced supply will be available by 2004. Adding Canadian surplus production and only 50% of the other world-wide surplus we calculate 8.0 billion gallons of additional supply will be available during the next 15 years. If we add the gas liquids planned for export from the Alaskas North Slope the additional supply grows to 11.0 billion gallons. This scenario does not include any of the 5.3 billion gallons currently going into the chemical market simply because the price is cheap.

There is over seven billion dollars in LP-Gas infrastructure including 70,000 miles of pipeline, 22,000 railroad cars, 25,000 transport and delivery trucks, 250 primary storage facilities, 8,000 bulk storage and distribution terminals and 25,000 outlets.

In order to provide fuel for passenger cars, any alternative fuel will have to establish its infrastructure up front. The cost of building onto the existing LP-Gas infrastructure would be very low compared to building a methanol infrastructure from its current low levels.

The high cost of expanding alternative fuels into the passenger car market argues for the introduction of alternative fuels into the fleet market. The centralized refueling capabilities and high volume fuel use of fleets will cost much less than would an effort to serve the private passenger car market.

In summary, current and projected supply is more than adequate to operate a minimum of 6.5 million vehicles on LP-Gas. The LP-Gas infrastructure is well developed. Even in a high demand scenario, most of the LP-Gas will be domestically produced providing American jobs and energy security.

REAL WORLD SCENARIO - THE IMPACT OF LP-GAS

Translating data into a real life situation brings focus to the impact LP-Gas can have on the fleet market particularly for the non-attainment areas.

Statistics indicate that there is a total U.S. truck registration of almost 19 million. Of this number, approximately 8.5 million are in fleet use. We believe that LP-Gas and natural gas are particularly suited for that market characterized as fleets which return to a central base every night and which consist of vehicles that are five years old or less. We calculate this market to represent about 2.1 million trucks or 25% of the total U.S. fleet market.

School buses represent another prime market for propane use. School bus fleets from Florida to Oregon have been converted to propane. In this market, there are an estimated 352,434 school buses on which about $5.75 billion per year is spent by school districts nationwide. It has been proven that propane can cut costs, extend engine life and reduce maintenance on these vehicles. In addition, school districts have approximately 11,000 underground storage tanks susceptible to leaks compounding the problem of contaminated water.

The Duluth, Minnesota city fleet runs over 300 vehicles on LP-Gas. According to Joe Merritt, Mechanics Supervisor for the city, "Propane motor fuel, in fact, has virtually made Maytag repairmen out of my assistant and myself. Prior to converting our 15 snowplows to propane, we'd be lucky to get 60,000 miles on any of them before the engine was wiped out. Now, our engines are approaching 100,000 miles and the trucks are wearing out."

CONSUMER ACCEPTANCE

LP-Gas has shown tremendous consumer acceptance world-wide. In Canada there are over 160,000 vehicles operating on propane with over 4,000 refueling locations. In the Netherlands 450,000 vehicles or 16.3% of the total motor fleet runs on LP-Gas.

There is no particular limitation on the size or kind of vehicle that can use LP-Gas. There are 450 buses in Vienna, Austria operating on LP-Gas. From taxis in Tokyo to police cars in Sarasoto to city trucks in Duluth, LP-Gas is cost effective in today's market. With the exception of Brazil's economically disastrous ethanol program, only LP-Gas represents substantial real world experience in alternative fuels.

It is logical to assume that the public will continue to accept a product with which it is familiar and which has a proven track record.

Flexible fuel and dual fueled vehicles have been offered as the best first generation of alternative fueled vehicles. LP-Gas is used in both dual fuel and dedicated fueled vehicles. The greatest emission reductions can be achieved from dedicated fuel vehicles. The problem with flexible fuel vehicles is getting the public to fill up with cleaner fuels. It is unlikely that given a choice of fuels the public will spend more money to buy methanol or reformulated gasoline if they are more expensive than conventional gasoline. We should be reminded of the experience with unleaded gas in the 1970s when many consumers would switch fuel in order to save a nickel a gallon.

LP-Gas offers the advantage of cost savings over gasoline and methanol especially when purchased in bulk for fleet use. The second benefit is that engines running on LP-Gas last longer and require less maintenance than the same engines running on gasoline or methanol. Therefore, consumers will have a real economic incentive to use LP-Gas.

EMISSIONS REDUCTIONS

We believe that all alternative fuels have a role to play in reducing vehicular pollution. Whether or not the Federal government mandates alternative fuel use, the states will have to look at stricter controls on highway vehicles, off-road equipment and stationary engines to provide significant overall pollution reductions. For example, here in the Nation's Capitol motor vehicles are the single largest producer of air pollution.

Since the early 1970s the California Air Resources Board has approved the installation of LP-Gas equipment on vehicles after very tough annual certification test procedures. This approval is not gratuitous since the conversion process entails the incorporation of the LP-Gas system into all of the existing on-board emission control systems used for gasoline. Because the technology of LP-Gas systems has evolved right along with gasoline systems, retrofit of current engines is here today.

Hydrocarbon emissions from LP-Gas vehicles are 50 percent lower than those from gasoline vehicles used under the same conditions. The ozone reduction is even greater since the reactivity of LP-Gas in the formation of ozone is only 50 percent of that of gasoline. LP-Gas is non-toxic and does not increase the tail pipe emissions of formaldehyde. In addition, LP-Gas when released turns to vapor and cannot pollute underground wells or aquifers.

Preliminary EPA tests earlier this year of a 1988 Ford Crown Victoria sedan equipped with an LP-Gas (propane) fuel system showed average emission levels for most pollutants below those for the same vehicle powered by gasoline. Carbon monoxide, oxides of nitrogen and greenhouse gases (carbon dioxide and methane) were much lower. All pollutants were well below the emission standards the car was designed to meet. If the car had been fully optimized to run on LP-Gas, these levels would have been even lower.

HARDWARE AND SAFETY CONSIDERATIONS

There are four basic components required for the conversion of a gasoline engine to operate on propane: the fuel tank, lockoff valves and filters, the converter, and the carburetor. LP-Gas motor fuel tanks must be constructed to codes and specifications established by the U.S. Department of Transportation and the American Society of Mechanical Engineers. Other components are listed by Underwriters Laboratories and meet stringent industry standards.

LP-Gas containers have survived nuclear tests in the Nevada desert and crash tests in Holland where 16% of all vehicles run on LP-gas. The Research Institute for Road Vehicles TNO of Delph, The Netherlands conducted several high speed tests on LP-Gas fueled vehicles. The conclusions of the test show that LP-Gas containers retain their integrity in crashes that destroy the vehicle. In fact, those who know would rather ride with a propane tank than with a thin sheet metal gasoline tank.

CONVERSIONS AND COSTS

Vehicles can be manufactured to run on LP-Gas or existing gasoline vehicles can be converted to run on LP-gas. Ford currently manufactures a straight propane powered medium duty truck. Both Ford and Chrysler produced propane powered cars in the early-mid 1980s. Most cars running on LP-Gas have been converted from straight gasoline power.

Conversion costs are usually in the range of $1000-$1500 per vehicle. Payback costs come in reduced fuel costs and in lower maintenance. It usually takes 2-3 years to recover the investment; the higher the milage the quicker the return.

An LP-Gas vehicle's cost per mile is normally 25 to 30% lower than gasoline. In small quantities the cost per gallon ranges from near equal with gasoline to a savings of 40%. In larger fleets (over 15 vehicles) purchasing fuel in transport quantities savings of 20-55% have been realized.

LP-Gas, when used as a motor fuel, pays nine cents per gallon Federal highway tax, the highest of all fuels on a BTU basis. State taxes are either paid by a flat fee per vehicle or on a per gallon basis. We know that there are already tax incentives in this country for certain fuels such as ethanol. In Europe and Canada, tax incentives for LP-Gas have proven very effective in stimulating demand for LP-Gas vehicles. Alternative fuel use can be promoted through tax policy as well as through regulation.

CONCLUSION

We continue to believe that there is no one alternative fuel that will provide a panacea for clean air problems or for energy security. The United States should diversify its motor vehicle fuel dependency.

NPGA and GPA support the inclusion of a balanced alternative fuel provisions in clean air legislation. Public policy stands on firm ground when it makes choices among proven options. This is why LP-Gas, butane and propane, will prove to be a solid player in the alternative fuels market, because LP-Gas is already proven. It is available today to start reducing air pollution. We do not have to wait for new clean fuel vehicles or a sufficient supply of other clean fuels.

By creating the level playing field, market proven fuels such as LP-Gas and CNG will develop quickly while unproven fuels such as methanol can continue to develop. We believe that LP-Gas will continue to serve as a secure and environmentally beneficial alternative fuel.

The CHAIRMAN. Thank you, Mr. Myers.
Mr. Vaughn.

STATEMENT OF ERIC VAUGHN, PRESIDENT AND CHIEF EXECUTIVE OFFICER, RENEWABLE FUELS ASSOCIATION

Mr. VAUGHN. Thank you, Mr. Chairman. My name is Eric Vaughn and I am the President and Chief Executive Officer of the Renewable Fuels Association. That is the national trade association for the domestic ethanol industry. I have prepared a statement and submitted it, and I hope I could have it included in the record and I will try to summarize my comments so that we can speed the hearing along.

Ethanol, as many members of this Committee are fully aware, is a wide use fuel alternative in a blend, and some 9 billion gallons of ethanol-enhanced gasoline will be sold and marketed all across the United States this year.

Since the beginning of the ethanol industry, essentially in 1980, some 700 billion miles have been driven on ethanol-blended fuels. All 19 world-wide auto manufacturers marketing cars in the United States fully warranty ethanol blends today.

Mr. Colucci mentioned in his comments briefly that the 1990 auto warranty statement for GM had some additional language. I would like to read for the record that language.

This is the 1990 warranty language for General Motors automobiles, and it says,

> The use of oxygenated materials in gasoline can contribute to cleaner air, especially in those parts of the country where carbon monoxide and ozone levels are high. Where available, General Motors recommends the use of oxygenated fuels such as MTBE and ethanol in gasoline.

We would wish that they had included ETBE in that as well, but maybe the 1991 warranty statement will have ETBE in there as well.

I would like to point out for the record that in addition to the 1990 warranty statement being as promising and as promotional as that language is, GM has warranted all of their automobiles since 1980 to run very effectively, without difficulty or problems for their consumers, on 10 percent ethanol blend.

Today's consumers get, when they purchase an ethanol blend, increased performance and proven quality with ethanol. It is one of the very best fuel alternatives available today, when dealing with carbon monoxide, ozone and carbon dioxide pollution problems.

The hearing attention today being focused on alternative fuels comes at an excellent time. It also comes at a time when just down the hall the Environment Committee is focusing attention on the role of alternative fuels from an environmental standard.

In effect, our national energy policy for the coming decade could be well-established by the actions taken in that Committee and on the floor of the Senate early next year. The focus of attention today on blends, alcohols and ethers and gasoline that already exist today, or reformulated gasoline, the higher use of alcohols and ethers and higher blends that may achieve waiver status of EPA or the use of neat alcohol or ether fuels in the future is something that has been an exciting opportunity for all of us to participate in.

I was struck by several comments made by some of the representatives from the auto and oil industry on the earlier panel, and your question, Mr. Chairman, regarding the types of fuels that would be tested.

The fact is that the government does not play a role in this testing. The fact is, the automobile manufacturers and the oil manufacturers will decide what fuels are tested. More importantly, what types of fuels fit within those categories.

Mr. Chairman, you did not receive an affirmative answer, and at this point we do not know if ETBE will be tested, but I can guarantee you on the basis of the comments that we heard and the meetings taking place tomorrow that the most widely used alternative fuel today, ethanol blends, will not be tested.

When the test results come out, we will not know how ethanol blends compare with ETBE or MTBE, or any other fuel formulation. That is a mistake, and it is a mistake this Committee should not allow to occur.

Our clean air legislation is going to focus attention on the ability to use a variety of fuel formulations and alternative fuels to address a number of critical issues.

Maybe one of the most critical of those issues that so far has escaped the attention of both the Administration and the Committee on the Environment and Public Works, is the ability to reduce benzene, tolulene and xylene levels to effect cleaner air and healthier products across the board.

There is no question that EC-1 is moving in that direction. Have they moved far enough? The answer to that is, there is no question they have not moved far enough.

We can move much more effectively and much more aggressively to reduce benzene and toluene air toxics, but much more importantly, xylene, which is known to be probably the single worst actor in gasoline for the formation of ozone. Those concentrations of aromatics can be very effectively and economically replaced by ethanol and/or the ethers.

A comment this morning was made with regard to ethanol's cost effectiveness. The fact is, right now, today, ethanol is more cost effective than benzene. Ethanol is as benign as this glass of water to the environment and to the health. Benzene—we all know the story there.

We need to establish and see this committee push for the establishment of performance standards for fuels. The oil community and the auto community should be congratulated for what they are doing, but the fact is, it was this committee, and the Committee on Environment and Public Works, that pressed these industries into moving on reformulated. We should not miss this opportunity to establish tough, rigorous and fair performance standards.

The fact is that in addition to what we can do on reformulated gasoline in existing fueled vehicles, we can move ahead on neat fueled vehicles. We look forward to that debate, and we look forward to participating in those fuel formulations.

Mr. Chairman, on behalf of the ethanol industry I thank you for holding this hearing and thank you for the invitation today.

[The prepared statement of Mr. Vaughn follows:]

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TESTIMONY OF
ERIC VAUGHN
PRESIDENT & CHIEF EXECUTIVE OFFICER
RENEWABLE FUELS ASSOCIATION

BEFORE THE
COMMITTEE ON ENERGY AND NATURAL RESOURCES

WASHINGTON, D.C.
NOVEMBER 14, 1989

On behalf of the members of the Renewable Fuels Association, the national trade association for the domestic ethanol industry, I want to thank you for this opportunity to testify before the members of the Committee on Energy and Natural Resources regarding potential alternative energy sources for transportation.

INTRODUCTION

The United States fuel ethanol industry has a current operational production capacity of over 1 billion gallons per year. More than 60 ethanol manufacturing facilities located in 22 states are operating today. Domestic ethanol producers have invested over $2.5 billion in private sector resources to construct modern and efficient ethanol production facilities.

In 1988 alone, 850 million gallons of ethanol were produced from 340 million bushels of surplus grain. As a direct result of ethanol production, it is estimated that farm income in 1988 increased $750 million, federal farm program costs were reduced by nearly $600 million, and crude oil imports fell by 40 million barrels.

Fuel grade ethanol became commercially available in the U.S. in the late 1970's in response to a national policy to promote the development of domestically produced alternative energy sources to reduce our dependence on foreign oil.

Today, ethanol/gasoline blend sales represent over 8 percent of all motor fuels sold in the U.S. While ethanol was originally used as a gasoline extender, capable of stretching tight gasoline supplies, ethanol is currently marketed as a high quality octane booster capable of improving automobile performance by adding 3 octane points with every 10% ethanol blend. In the future, we expect ethanol will be marketed as an ether based oxygenate - ethyl tertiary butyl ether (ETBE). ETBE has the potential of opening major new markets for ethanol because it can be blended at refineries and shipped through common carrier pipelines. In addition, ETBE can actually reduce the volatility of the base gasolines with which it is blended. While ETBE is not yet commercially available, it promises to be a valuable supplemental market to 10% ethanol blends and a natural competitor to the only ether based oxygenate available today-methyl tertiary butyl ether (MTBE).

Over the past ten years, ethanol blended fuels have won wide consumer acceptance as a high octane, high performance gasoline additive. In fact, since 1980, over 700 billion miles have been driven on ethanol blended fuels. One indication of the continuing and growing demand for ethanol blends are the market penetration levels in states where ethanol is sold. In 1988, 10 states recorded market penetration levels for ethanol that range from 16% to 39%. States with the highest market penetration levels are as follows: Kentucky, Iowa, Nebraska, Illinois, and Indiana.

Furthermore, ethanol blends are approved under the warranties of all 19 domestic and foreign automobile manufacturers marketing vehicles in the U.S. In fact, earlier this year, Roger B. Smith, Chairman of General Motors, announced that beginning with 1990 model cars and trucks, GM would begin recommending the use of oxygenated fuels. In making the announcement, Smith stated, "The advantage here is that the oxygen from the ether or alcohol portion of these special fuel blends can act to make the engine's air-to-fuel ratio leaner, (and) the result is less carbon monoxide." The new GM warranty language reads:

> Gasolines for Cleaner Air
>
> The fuel that you use can contribute to cleaner air. General Motors recommends that you use only gasolines treated with detergent additives that prevent deposit formation in your engine. These gasolines will help keep your engine in tune and your emission control system working properly.
>
> The use of oxygenated materials in gasoline can also contribute to cleaner air, especially in those parts of the country where carbon monoxide and ozone levels are high. Where available, General Motors recommends use of oxygenated fuels such as MTBE and ethanol in gasoline.

ENERGY SECURITY AND ALTERNATIVE FUELS:

In his June 1989 speech in Lincoln, Nebraska, President Bush said, "America must work toward energy independence... I will not stand by and watch our country slip back into a dangerous state of dependency -- wide open to the next oil shock from some went to the Arab members of OPEC. The Free World as a whole spent an incredible $1.6 trillion on oil imports during this decade, constituting the largest transfer of wealth since the Spanish looting of the New World. In the peak year, 1980, U.S. oil imports cost consumers $78.6 billion, with $54 billion going to the Arab members of OPEC.

This growing dependence carries with it significant hidden costs which far exceed the nominal price America pays for its imported oil. According to the National Defense Council Foundation, "the total for both defense related outlays, and economic costs comes to $45 billion. When averaged across the total of domestic oil imports last year, this amounts to $18.91 per barrel. If military outlays are attributed solely to imports from the Persian Basin, the cost of oil from that region comes to $49.04 per barrel."

Clearly, our economic well-being hangs by a very fragile thread. With demand for energy up and supplies again tightening, the days of cheap oil are numbered: the question is not whether we will have to adjust to this, but how. As some headlines have recently asked: "Are Gasoline Lines Coming Back?"

To fail to develop new sources and efficient processes, as oil becomes more expensive, is to jeopardize the nation's future economic health. One way to deal with this threat to our energy security is an increased use of alternative fuels -- such as ethanol.

The energy security of this country is a critical component of our national security. With our continued reliance on foreign oil, any major disruption in our oil imports would result in a dramatic rise in oil prices. This would lead to a fall-off in global trade, rising food and fertilizer prices, and diversion of scarce resources away from social and economic priorities to pay for oil imports. Such a situation can be avoided by supporting and further developing alternative fuels such as ethanol.

Clean Air Legislation and Energy Security

The reauthorization of the Nation's clean air laws will have as profound an impact on energy prices, supplies and markets as the two oil embargoes of the 1970's combined. The clean air legislation working through the Congress addresses a range of complex environmental problems caused by transportation fuels that endanger our health and safety and jeopardize global development.

In fact, there are those that maintain that by formulating an environmental policy for the 1990's, we are in fact deciding on an energy policy to take us into the next century. We would certainly agree. The choices the Congress makes in environmental policy will have a profound impact on our nation's energy security. Will we continue our growing dependence on foreign country halfway around the world. We're not going to do that in this country. We've got to plan for the future now. We need secure, reliable sources of energy right here at home. Alternative fuels are an American answer."

In the 1970's the impact of the two oil embargoes put our nation's energy security at risk. We responded to that challenge by developing an alternative fuels industry capable of lowering our dependence on foreign oil. Alternative fuels -- such as ethanol -- became a symbol of our national commitment to break our expensive habit of increasing dependence on imported oil.

Despite the growth of the alternative fuels industry, our energy security is, once again, being threatened by decreased domestic oil production and rising imports.

Consider these statistics:

o U.S. imports of crude oil and petroleum products have risen 54% over the past three years.

o Since the oil price collapse in 1986, our domestic oil production has declined, our consumption has increased and we are now importing more oil and finished gasoline than at any time since 1964.

o Total oil imports in April averaged 8 million barrels per day - 15% higher than the 7 million bpd in April 1988.

o Imports for the January - April period averaged 7.8 million barrels per day -- this was 13.5% higher than the comparable period in 1988 and 53.9% higher than the 5.1 barrels per day imported during the first four months of 1986.

o Petroleum imports in April as a percentage of total U.S. domestic petroleum deliveries totalled 47.6%; imports as a percentage of same month in 1988 were 42%.

o The active rotary drilling rig count in U.S. as announced May 15, 1989 was 771; average for 1988 was 937. In December, 1981, we had an all-time high rig count of 4,530.

o Today, 19% of the non-communist oil production must pass through the chokepoint of the Hormuz Strait.

o Estimates are that a cut-off of oil through the Straits of Hormuz could send prices to $50 bbl.

o Many analysts are predicting that U.S. oil imports could increase to a level between 50 and 60% in the 1990's.

In the ten years following the OPEC oil embargo, the U.S. paid more than one-half trillion dollars for imported oil. Of this, some $324 billion went to OPEC nations, and $154 billion oil? Will we shift that dependence to an alternative energy source which is largely imported? Or will we pursue a strategy which maximizes both our energy and environmental security?

In recent years, the remarkable growth of the ethanol industry has been directly related to its increasing use as a weapon against air pollution for the nation's 90 carbon monoxide and ozone non-attainment cities. Many state and local governments are beginning to recognize the enormous environmental benefits of ethanol and are looking at programs to increase the use of ethanol blends as a means of reducing dangerous levels of carbon monoxide and ozone. One such program in Colorado has been highly successful in reducing CO in Denver's Front Range, previously the worst area for CO in the country. The success of this program has prompted other states, such as Arizona, New Mexico and Nevada, to adopt oxygenated fuel programs in their State Implementation plans to come into compliance with EPA standards.

Ethanol and ETBE have a number of air quality and public policy benefits which must be considered in the context of Clean Air Act reauthorization. First, because the oxygen content of an ethanol blend is almost twice that of other oxygenated fuels, its ability to reduce carbon monoxide (CO) levels is greater than any alternative oxygenated fuel. The use of ethanol blends will reduce motor vehicle emissions of CO by 25 - 30 percent. Second, recent analysis indicates that ethanol blended fuels can reduce the formation of urban ozone, a fact recognized by the U.S. Environmental Protection Agency as early as January, 1988. Finally, ethanol is an effective and safe replacement for dangerous aromatic octane enhancers in gasolines today.

Ethanol As A Carbon Monoxide Emissions Control Strategy

The addition of molecular oxygen contained in ethyl alcohol (C_2H_5OH) causes more air to be available in the fuel, thus the air/fuel ratio in the internal combustion engine is altered to the extent that the engine is more efficient in converting toxic carbon monoxide to non-toxic carbon dioxide.

Since 1987, EPA has recognized that the use of ethanol blends can reduce fleetwide carbon monoxide exhaust emissions by 25 percent. EPA published a technical document to be used by the States in revising their SIP's in the post-1987 era, "Guidance on Estimating Motor Vehicle Emissions Reductions From the Use of Alternative Fuels and Fuel Blends." This document lists the following exhaust emissions reductions that can be achieved by using ethanol blends:

non-catalyst (pre-1974 vehicles)	-22.8 percent

open-loop catalyst (1975-1981 vehicles)	-33.4 percent
closed-loop catalyst (post-1981 vehicles)	-17.2 percent

Carbon monoxide is an intermediary component of combustion. Normally it proceeds to be completely oxidized into carbon dioxide (CO2) during the later stages of combustion. But it can remain a pollutant if (1) the combustion gas temperatures are low; (2) if the duration of time it spends in the combustion process is short; and (3) if there is a lack of oxidants; i.e., oxygen-containing molecules. Increasing the air/fuel ratio present during combustion results in more oxidants being present and higher gas temperatures both of which increase the efficiency of the oxidation of CO into CO2.

The higher the percentage of oxygen by weight in the fuel, the "leaner" the effective fuel-to-air ratio will be; that is, more oxygen is available to enhance the combustion process. As the fuel-to-air ratio becomes leaner, CO emissions are reduced. "Oxygenated" fuels produce a reduction in CO emissions directly related to the leaning effect they have on a vehicle's engine. The percentage of oxygen by weight in the automobile's final fuel determines the amount of CO emissions reduction. Hence, there is no question that ethanol blends substantially reduce CO emissions. This occurs because of the high oxygen content of ethanol. The oxygen content of gasohol is 3.5 percent by weight.

Indeed, to combat its significant CO nonattainment status, the State of Colorado, after several years of exhaustive analysis, promulgated a regulation which requires that only oxygenated gasolines be sold during the winter months along the Colorado Front Range.

The CO emissions reduction capability of oxygenates was corroborated in EPA testimony on June 17, 1987, before the House Subcommittee on Energy and Power, when the director of EPA's Office of Mobile sources stated that:

> "Based on the types of vehicles in the in-use fleet today, our analysis indicates that the use of (oxygenates) would reduce motor vehicle emissions of CO by approximately 22 percent."

A tremendous amount of research to document the impact which oxygenated fuels have on CO emissions reductions is generally available.

Given the very few control options available for CO reduction it appears both reasonable and necessary that all CO nonattainment areas be required to either implement an oxygenated fuels program, or show why comparable emissions reduction will be obtained in the absence of such an oxygenated fuels program.

Ethanol, ETBE and Ozone Pollution Levels:

Ozone pollution continues to be a major concern for large urban areas throughout the United States. A recent analysis performed by SAI conclusively documents that reductions in carbon monoxide caused by ethanol blends in most instances completely offsets any increase in ozone formation attributable to the increased volatility of ethanol blends, and, in fact, at RVP's of 9.0 psi and lower, ethanol blends slightly reduce ozone formation.

Based on their review of SAI's analysis, EPA agreed that reductions in carbon monoxide should be considered with regard to ozone abatement efforts. In a January 1988 document EPA stated:

> "Areas receiving ozone SIP calls and considering adoption of an alternative fuels program should account for its impact on both hydrocarbon and CO emission inventories, since both are inputs to the latest model for predicting future ozone attainment. Directionally, CO emission reductions from alternative fuels will assist in attaining the ozone NAAQS, but the strength of this effect has not yet been documented for the range of local conditions which affect ozone formation." (Guidance on Estimating Motor Vehicle Emission Reductions From the Use of Alternative Fuels and Fuel Blends, January 1988, at page 1) (emphasis added)

In order to further measure "the strength of this effect," EPA's Office of Policy, Planning and Evaluation (OPPE) contracted with Systems Applications, Inc., to perform more rigorous ozone modeling (using the Urban Airshed Model) to more fully ascertain the impact on ozone formation attributable to the use of ethanol blends. The initial results of this study are contained in the May 1989 report, "A Low-Cost Application of the Urban Airshed Model to the New York Metropolitan Area and the City of St. Louis." Although EPA has released this report, it has not been widely disseminated, and, quite frankly, I believe its conclusions have not received the attention due them.

In the computer modeling approach utilized in these studies, the Urban Airshed Model is employed in such a manner so as to take into account time-dependent chemistry associated with hydrocarbon emissions. This is a very important factor, given that many critics of ethanol blends contend that emissions from ethanol blend-fueled vehicles, while not as immediately photoreactive as gasoline-fueled vehicle emissions, form more ozone over time. The report indicated that this is not the case.

Of the various emissions inventories modeled in this study, included is a 1995 modeling scenario for New York City with 100-percent market penetration of a 10-percent ethanol blend with a 10.0 psi RVP (9.0 psi RVP base fuel, 1.0 psi RVP increase attributed to ethanol); and a 1995 modeling scenario for St.

Louis with a 50-percent market penetration of a 10-percent ethanol blend with a 9.8 psi RVP (8.8 psi RVP base fuel, 1.0 psi RVP increase attributed to ethanol). Both modeling scenarios took running losses into account.

For the New York modeling scenario, the report states that, "There is a very slight increase in the maximum daily ozone concentrations, with a maximum increase of less than 1 part per billion... Examination of the difference in hourly ozone concentrations between the ethanol-blend scenario and the low-RVP scenario ... reveals that the effects of ethanol blends on hourly ozone concentrations are very small, with ozone increases or decreases always less than 1 part per billion."

For the St. Louis modeling scenario, the report states that, "the use of a 50-percent market penetration of a 10-percent ethanol-blended fuel with the 1.0 psi exemption results in no increase in the highest ozone concentrations and a slight increase in the maximum daily ozone concentration."

I believe these conclusions, based on the very best technical data base and computer modeling available in the country, are of significant importance to the ongoing debate on the impact of ethanol blends on ozone formation. I believe the results of this exhaustive and thorough study should put to rest, once and for all, the assertion that ethanol blends either now contribute to the ozone problem experienced in metropolitan ares, or would contribute to increasing ozone formation in those areas in which they gain an increased share of the motor fuel market. The plain and simple truth is --- ethanol blends don't contribute to the ozone problem.

These up-to-the-minute results, obtained by the use of state-of-the-art ozone computer modeling, should provide the Committee with further assurance that providing a volatility tolerance for ethanol blends continues to be the appropriate choice in the gasoline volatility section of the Committee's Clean Air Act legislation.

Impact of Lead-Phasedown and Aromatic Content Increase:

Gasoline, today, is a complex mixture of over 200 hydrocarbons. The hydrocarbon composition -- or octane level -- of fuel will determine the propensity of a gasoline to resist "knocking". The higher the octane number, the lesser the tendency of the gasoline to "knock". Over the years, as increased performance has been demanded from automobile engines, greater compression ratios in an engine's cylinders has been necessary, requiring higher and higher gasoline octane levels.

In the 1920's research determined that the octane level of fuel could be increased by the addition of tetraethyl lead. Research studies in the 1970's, however, discovered potential health problems associated with the use of lead in gasoline and on December 6, 1973, the U.S. EPA mandated reductions in the lead content of gasoline beginning January 1, 1975.

One result of the lead-phasedown program has been an increase in the aromatic content of gasoline as a means of replacing the lost octane value previously represented by tetraethyl lead. The aromatic fraction of gasoline has increased an estimated 50% in the last 8 years and EPA documents suggest that by the 1990's it is expected to double from pre-lead phasedown levels.

Moreover, the use of aromatics in gasoline will continue to increase as a result of EPA's fuel volatility standards. This increase in aromatic levels has raised serious concerns about the health and environmental implications of such components when emitted into the air. As more and more scientific information becomes available, the significant health risks associated with aromatic emissions becomes clear. Finally, the increasing percentage in gasoline of highly photoreactive compounds will continue to exacerbate the problem of ozone formation.

Therefore, it would appear that reductions in the aromatic fraction of current gasoline composition would have the beneficial result of not only reducing health risk to the public associated with these compounds, but if less photochemical reactive compounds were utilized in gasoline in their place, it would also assist in the reduction of ozone formation.

The three largest aromatic hydrocarbon components of gasoline currently are: benzene, toluene, and the mixed xylenes, known collectively as "BTX".

BENZENE: It is the basic aromatic in the BTX group. Highly valued as a chemical feedstock. It is estimated that the proportion of benzene in the domestic gasoline pool has increased by at least 50 percent since initiation of lead phasedown, and in fact, the liquid benzene level in gasoline has more than likely doubled in the past 15 years. It should also be noted that the upper range of liquid benzene content in gasoline is approaching 5 percent in summertime usage.

Benzene is a known carcinogen. The Senate Environment and Public Works Committee report on the Clean Air Act Standards Attainment Act of 1987 noted a study in Los Angeles that "as many as 222 cancers per year in that community could be attributed to toxic air pollutants, principally benzene emitted from gasoline supplies". Also, in a series of toxicological studies the effects of exposure to this hydrocarbon was revealed. For instance, in a recent report released by California's South Coast Air Quality Management District, and funded by the U.S. EPA, researchers found that benzene posed the greatest health risk of all 16 air toxins studied. Study authors also concluded that there is a one in 10,000 chance of getting cancer from benzene exposure, and that 15 percent of those cases would be due to exposure during commuting to and from work.

TOLUENE: At significant exposure levels, toluene can produce impaired human motor functions and distortion of thought processes. It is the most common hydrocarbon octane enhancer purchased by refineries for use in increasing octane. Almost two-thirds of the airborne toluene emissions in 1978 were attributable to gasoline sources: gasoline refueling, automobile evaporative emissions, and automobile exhaust emissions. Consistent with the assumption applicable to populations at risk for exposure to airborne benzene emissions, it can be assumed that urban populations are exposed to larger amounts of airborne toluene from gasoline refueling and automotive emissions than non-urban populations, and sub-populations in close proximity to areas of congested traffic, service stations, and petroleum are at greatest risk.

As is the case with benzene, toluene levels in the domestic gasoline pool since lead phasedown have increased by at least 50 percent, and perhaps substantially more. The amount of isolated toluene used for octane enhancement was estimated at 290-300 million gallons in 1986, up 90-100 million gallons over 1985, accounting for 33 percent of total isolated toluene supply. Toluene ranks third in importance as a discrete octane enhancing blending agent for gasoline. Overall, of the 3.24 billion gallons of BTX supply available in 1986, after separation from the reformate supply stream, the 300 million gallons of toluene in gasoline represents 9 per cent of BTX supply with the balance used as petrochemical feedstocks.

MIXED XYLENES: The health effects of xylene are also well known. A 1984 EPA study, "Health Effects Assessment for Xylene," noted that pregnant women, and hence embryos, fetuses and young children, exposed to xylene should be considered a high risk sub-population.

Xylene is an aromatic compound which is a minor component of the BTX group. It has high value as a chemical feedstock. Mixed xylenes have increased in the domestic gasoline pool since implementation of lead phasedown by at least 70 percent, and perhaps substantially more at present time.

Because they are hydrocarbons, these aromatics, when released as emissions into the atmosphere, act as a chemical precursor (along with nitrogen oxides and sunlight) in the formation of ozone. Among the aromatics, however, there are varying degrees of relative photochemical reactivity. Toluene, for example, is not very photochemically reactive. Benzene, is more photochemically reactive than toluene, but is only classified as a moderate precursor of ozone. The xylenes, however, are extremely photochemically reactive, and react in the atmosphere to form significant amounts of ozone in much greater proportion over shorter periods of time than do benzene and toluene.

Reformulating Gasoline:
Reducing Aromatics and the Benefits of Ethanol:

While the EPA lead-phasedown program was perhaps the first federally mandated reformulation of gasoline, the recognition of other environmental problems has re-focused attention on steps which can be taken to "reformulate" gasoline to assure a clean-burning motor fuel. Supporters of reformulated gasoline advocate that the concentration of certain gasoline components could be altered to achieve desired environmental benefits. As an example, reducing the level of xylene could reduce formation of ground level ozone and the addition of oxygenates would dramatically reduce tailpipe emissions of carbon monoxide. Some action, such as a proposed strategy by the U.S. EPA to reduce benzene emissions from stationary sources, has been taken to date, but there is much more which can and should be done.

While we all are encouraged by the current interest on the part of the U.S. oil industry to "reformulate" their product to respond to pressing environmental needs, as with the lead phasedown, it will take Congressional action to assure that "reformulated gasolines" meet maximum environmental standards. In the coming months, many definitions of reformulated gasoline will be offered, but we would suggest the following formulation:

Oxygen	3.1%	Minimum	(to reduce tailpipe emissions of carbon monoxide)
Sulfur	0.03%	Maximum	(to reduce acid rain)
Benzene	1.5%	Maximum	(to limit benzene levels)
Aromatics	25%	Maximum	(to limit photochemically reactive components)
Olefins	9-18%	Maximum	(to limit photochemically reactive components)
RvP	9.0 psi	Maximum	(to reduce evaporative emissions)

The increased use of high octane-oxygenated blending components, such as ethanol, can go a long way toward reformulating gasoline to meet all of the above requirements while assuring the continued availability of high performance motor fuels which American consumers have come to expect. Ethanol is an effective octane alternative for lead without the carcinogenic problems associated with aromatics. The addition of ethanol could proportionately reduce the amount of aromatics in the base gasoline and thus its presence for octane enhancement purposes can significantly reduce benzene levels in automobile exhaust.

Furthermore, non-benzene aromatics in gasoline, such as toluene, are precursors to benzene exhaust in the combustion process. Thus, not only does the addition of ethanol proportionately reduce the amount of aromatics in the base gasoline, its presence for octane enhancement purposes can significantly reduce benzene in automobile exhaust.

In addition to the environmental benefits, there are technical advantages to blending ethanol for octane as well. Some in the petroleum industry have suggested that one significant problem with the increased use of aromatics is the inability of heavier hydrocarbon ingredients to distribute octane evenly throughout the full gallon. The result is that the desired effect of a high octane level in the fuel is not achieved during the combustion process and performance is thereby affected.

With ethanol, that is not the case. As an alternative to aromatics, it has the ability to contribute significant octane to the front end portion of the gallon of fuel, thereby providing the proper distribution of the octane level needed while also substituting for the toxic aromatic components.

Ethyl Tertiary Butyl Ether (ETBE)

In the effort to reformulate gasoline, a new ethanol based fuel, ETBE (ethyl tertiary butyl ether) holds great promise. ETBE is a new oxygenated fuel that is produced by mixing ethanol and isobutylene and reacting the mixture over heat with a catalyst. Each gallon of ETBE contains 40% ethanol.

Today, approximately 15% of the nation's gasoline is blended with an ether-based fuel additive manufactured from imported methanol - MTBE (methyl tertiary butyl ether). As a new market for domestically produced ethanol, ETBE has several significant advantages over MTBE. ETBE is only slightly soluble in water and has higher octane compared to MTBE, so refiners could make high octane gasolines that can be shipped in pipelines. Also, ETBE's blending vapor pressure is low, and thus provides advantages in meeting seasonal fuel volatility standards. Finally, ETBE has a greater molecular weight than MTBE, increasing producer's flexibility and providing a higher quality oxygenated fuel.

The most likely market for ETBE blends would be as an oxygenated fuel and octane booster in PADD I and PADD IV. These are coastal regions dominated by the major oil companies and established MTBE markets. There is presently no economic alternative to imported methanol as a feedstock for MTBE. However, domestically manufactured ETBE could compete with MTBE in established markets while opening new markets for ETBE blends in other regions of the country.

The domestic ethanol industry believes that over time ETBE may capture as much as 35% of the ether market. Given the lead time necessary for refiners to develop ETBE production capacity, and the growth pattern of the MTBE market, our industry estimates that an additional 350 million gallons of ethanol for ETBE manufacture may be necessary by 1995.

Because carbon monoxide (CO) reductions are relative to oxygen content, ETBE will not be as effective as 10% ethanol blends, which have an oxygen content of 3.5%. But ETBE will reduce CO emissions about 57% as much as ethanol blends while also reducing the vapor pressure of the finished gasoline. ETBE has a blending RVP of 4-7 psi, thus lowering the RVP of the blended product by about .2% in an 8% blend. This lower volatility will allow refiners greater flexibility in the use of butanes and will allow them to "reformulate" their gasoline by decreasing their reliance on aromatics.

Ethanol and ETBE have a significant number of environmental benefits. But they also have the ability to act as effective octane alternatives for lead and for toxic aromatic components. Ethanol and ETBE can be effective tools in any nationwide strategy to significantly reduce harmful gasoline benzene and aromatic levels in our fuel supplies, while maintaining the high-performance and high octane that American consumers have come to expect from their gasolines.

Ethanol and a New National Energy Policy

U.S. Energy Secretary James Watkins announced that DoE will develop a National Energy Strategy to provide the United States with adequate supplies of clean, competitively priced energy into the future.

Secretary Watkins has stated, "The National Energy Strategy will guide the U.S. in achieving ample supplies of competitively priced energy in a manner sensitive to the environment, security and health needs of the American public .... (This Strategy) will serve as a blueprint for energy policy and program decisions. This strategy will chart our course, set our pace, and provide mileposts by which to evaluate our progress in providing the energy our economy needs, while protecting the Nation's health, safety and environment."

Secretary Watkins pointed out the critical nature of our energy situation: "This Nation has come a long way from the crisis-driven decade of the 1970's. Today we use only slightly more energy than we did in 1973, yet our economy is 45 percent larger. We have added 70 million cars and trucks to the national fleet and 20 million more households. Yet the average new car sold in America travels twice as many miles on a gallon of gasoline as it did in 1973, and the energy we use per unit of economic production has dropped by 30%. We have built a powerful defense against oil market disruptions by investing in the 570 million barrel-strong Strategic Petroleum Reserve. We start with a good inheritance. But we must do better."

It has been well over a decade since our nation has grappled with developing a comprehensive energy strategy for our future. As the Department of Energy now begins to formulate a plan for the next generation, it is essential that alternative fuels -- such as ethanol -- play a vital role in that policy. The significance of that role, however, hinges on continued growth of the domestic ethanol industry.

The essential steps needed to ensure the expansion and growth of the domestic ethanol industry as we enter the decade of the 1990's include the following:

EXTENSION OF THE FEDERAL EXCISE TAX EXEMPTION. The domestic ethanol industry's top priority is the extension of the six cent federal excise tax exemption for ethanol blends. The lead time necessary to build a commercial scale ethanol production facility is two and a half years. This means that any facility conceived today could not be on line before late 1991, just two years before the excise tax exemption expires. Without the exemption, new plants cannot project an adequate return on investment, thus new plants are not likely to be built. In fact, today there is more than 500 million gallons of planned ethanol production capacity currently on hold pending an extension of the excise tax exemption. In addition, existing facilities planning production expansions are finding the time frame for investment recapture to be insufficient. Extension of the excise tax exemption would signal a renewed national commitment to the development, growth and vitality of the domestic ethanol industry.

ETBE AND THE CLARIFICATION OF THE BLENDERS CREDIT. Without question there is industry-wide recognition of the positive economic, marketplace and environmental benefits of the continued development and commercialization of ETBE.

As with any new article of commerce, of course, there are considerations such as production economies, co-feedstock availability, logistics, automotive issues, true market potential and public policy issues that must be addressed. Of critical importance to the industry, however, is the issue of adopting a strategy that promotes ETBE in concert with -- as a compliment to -- ethanol blended fuels. Hence, the domestic ethanol industry and the U.S. Congress should consider ETBE in the context of a long range developing product that will enhance the market for ethanol.

As part of this long range view, to encourage the production and use of ETBE, the definition of the blenders tax credit should be expanded to include ether manufactured from ethanol along with extension of the blenders tax credit to the year 2000 or beyond.

Additionally, Congress should consider directing the Department of Energy to initiate projects to address the any unanswered questions as well as research and development projects to accelerate its production and use.

REAUTHORIZATION OF THE CLEAN AIR ACT. As the Congress and the Administration act to reauthorize the Clean Air Act, a tremendous opportunity is at hand to take full advantage of oxygenated fuels in the fight against carbon monoxide, ozone and air toxics. The environmental benefits of oxygenated fuel use are directly related to the amount of oxygen in the fuel. A 10% ethanol-gasoline blend contains 3.5% oxygen content by weight, the maximum available from any fuel approved by the EPA for use today.

Therefore, a high oxygen content standard should be required for all fuels sold in non-attainment areas of the country, year round. Such an initiative, coupled with an oxygen content credits trading program, would provide maximum marketplace flexibility and deliver clean burning, low pollution fuels to areas with severe air pollution problems.

MARKETPLACE CONCERNS. Based on the increased market acceptance of ethanol, and the resultant loss in market share of an all hydrocarbon product, a number of major oil companies who do not market ethanol have embarked on negative advertising campaigns against ethanol for competitive reasons. The critical problem is that state labeling laws provide an unfair marketing tool for our competitors to use to reduce or eliminate ethanol sales. The ethanol industry has, in the past, supported reasonable and consistent labeling which should not put ethanol-gasoline blends at a competitive disadvantage in the marketplace. Therefore, if Congress wishes to encourage expansion of alcohol fuel blends, it should consider a preemptive pump label that is reasonable, consistent and treats all fuel components equally.

In addition to the pump labeling issue, there is the problem of fuel statements contained in vehicle owners manuals. Wording pertaining to ethanol is often overly cautious and at best confusing to the consumer. While these statements cannot be regulated out of existence, public policy could encourage the automaker to treat ethanol in a more positive fashion.

CONCLUSION

Little more than a theory a decade ago, fuel ethanol has become a major industry in the United States. It creates new jobs. It helps the rural economy. It reduces government farm program expenditures. It lessens our dependence on foreign energy imports, and improves our balance of trade. It also improves our environment by lowering carbon monoxide emissions, slowing the formation of urban ozone, and providing an alternative to toxic aromatic compounds. By requiring the increased use of oxygenated fuels - these proposals take a giant step toward cleaner air.

The CHAIRMAN. Mr. Glancey.

STATEMENT OF JAMES T. GLANCEY, CHAIRMAN, CLEAN FUELS DEVELOPMENT COALITION

Mr. GLANCEY. My name is Jim Glancey. I am president of Ethanol Marketing in Boise, Idaho, and chairman of the Clean Fuels Development Coalition.

First let me say that the CFDC is a true coalition. Our members represent the auto industry, ethanol producers and marketers, ETBE manufacturers, agricultural organizations and public interest groups dedicated to the expanded use of clean burning motor fuels.

CFDC supports the use of neat alcohol fuels, that is 85 percent by volume or more; oxygenated fuels such as ethanol and the ethers; and reformulated gasoline and diesel fuel; compressed natural gas, and any other fuel or technology which can reduce ozone, carbon monoxide, airborne toxics, and so-called greenhouse gases.

The CFDC was established in 1988 to ensure a vital role for these fuels in the proposed clean air legislation. As you know, the past 20 years Congress and various administrations have grappled with the problem of reducing emissions of ozone-forming compounds and carbon monoxide from the transportation sector, the single largest source of these harmful emissions.

Insofar as vehicle emission standards are concerned, the results are nothing short of remarkable; 96 percent reductions in the most harmful of these volatile organic compounds, mostly hydro-carbons; the automobile industry in cooperation with the Federal Government should be commended for producing the cleanest, most efficient automobiles possible for using existing technologies and fuels.

However, despite this apparent success, 101 cities remain in nonattainment of the national ambient air quality standards for carbon monoxide and ozone, as set forth under the Clean Air Act.

The CFDC believes the answer lies, not necessarily with the vehicles or their engines, but with the fuels they use. Therefore, the focus of new legislation should be directed toward improving fuel quality through the implementation and rigorous national motor fuel standards and specifications, especially regarding the concept of reformulated gasoline.

The fuel alcohol industry, both ethanol and methanol, has been working at it for over a decade, responding to policy initiatives developed by Congress in the late 1970s. Fuel ethanol is now blended in over 8 percent of the motor fuels sold in the United States. With a production capacity of over 1 billion gallons annually, ethanol production consumes about 350 million bushels of corn each year.

However, despite this success, fuel ethanol production falls far short of the 10 billion gallon per year target set forth by Congress during the last energy crisis as a matter of national policy by the end of the 1980s.

Overall, as you know, oxygenated fuels offer the following benefits: reduced carbon monoxide emissions, reduced ozone formation, lower concentrations of benzene in aromatics. The major expansion and production and use of ethanol for gasoline blends and as a feed stock for ETBE, is justified on policy grounds encompassing agricultural, energy, and the environment.

Expanded ethanol and ETBE production in the United States stands on a three-legged-policy stool: air quality, new markets for agriculture, and less dependence on foreign oil. Here lies the major rationale behind the longstanding congressional support for expanded ethanol and ETBE production and use.

The issue for the nation today is air quality, reformulated fuels and oxygenates, particularly, ethanol and ETBE. CFDC suggests that proper reformulation of motor fuels cannot be achieved without ethanol and ETBE. I further submit that reformulated fuels will not meet a prudent air quality test without a minimal annual average of 2.7 weight percent oxygen standard.

Both fuel ethanol and ETBE along with MTBE are superior motor fuel components for use in reformulated gasoline. Factors that should determine motor fuel quality include drivability and customer satisfaction, that is, mileage and performance, the environmental quality and pollution reduction of ozone, carbon monoxide, and the air toxics.

Each of these performance parameters can be enhanced by the use of oxygenated fuels. The reformulated fuels of the future will require different specifications in order to meet new U.S. performance and environmental standards, among them high octane, low vapor pressure, high oxygen content, lower reactivity, lower toxicity, renewably derived replacing the carbon dioxide and reducing greenhouse gases, and domestically produced, enhancing our energy security and reducing our balance of payments.

We think that ETBE is a promising fuel approaching commercialization that meets this criteria, and it may be the best long-term application of ethanol.

A key question to be answered regarding ETBE is how much of it can be made for sale in the gasoline marketplace. Since ETBE is made at a refinery through the reaction of fuel ethanol and isobutylene in the presence of a catalyst, it is necessary to have plentiful supplies of both fuel ethanol and isobutylene to meet the anticipated demand.

Given the Environmental Protection Agency's expected regulations to require further reductions in summertime gasoline volatility, this will generate excess butane, an isobutylene feed stock. I have enclosed an example as an appendies in my written testimony.

To clean our air now we propose the following reformulated gasoline strategy, which includes a clean fuel's credit system. These reformulated fuels can be used in the existing automobile fleet with great effect, reducing the need for more stringent exhaust emission standards.

This proposed system allows the refiner and marketer to determine the type of oxygenated fuel blend, which suits its individual needs with a minimum of government intrusion and regulation.

This system is designed to employ the best elements of EPA's gasoline lead content banking, trading and reporting system, which has been a proven success. The major elements of the proposed system are eight, and I have included them in my testimony. But basically the highlights are that, all motor fuels sold in a given ozone and carbon monoxide nonattainment area must meet an average oxygen content or equivalent requirement through the sale of gasoline containing various oxygenated fuels.

Other fuels, such as electricity and natural gas, can be given oxygenate equivalent values, thereby making them eligible for inclusion in this aspect of the program. The aromatic content and RVP of fuels would be limited, although regulatory flexibility allowing aromatic content averaging similar to that proposed for oxygenated fuels would be permitted.

The benefits and cost of such a program are presented in more detail in appendices B and C of the written testimony that I have submitted.

In conclusion, CFDC believes, pursuant to a broad oxygenated fuels policy, is sound energy and environmental policy for the United States. We should take a closer look at what we can do to accomplish this initiative most expeditiously.

In terms of what this distinguished committee can do, I respectfully suggest that you continue to support an investment in our nation's future through extension of the tax incentives that are currently in place. A renewed commitment to producing domestic energy may, if nothing else, serve to keep oil prices in check from foreign sources.

The tax incentive program that is currently in place is in our view an extremely cost-effective form of assistance. And if it were extended for another 10-year period, domestic ethanol production would expand significantly, providing all the benefits I have mentioned here today.

We should strive to improve better industry and government cooperation in a period of rapid fundamental change for the oil industry and for the international economic challenges faced by the United States.

It is my judgment that those companies which choose to mold their business and product development strategies consistent with changing U.S. energy and environmental priorities will be the winners in the political, economic, and customer satisfaction areas.

Thank you for allowing me to testify here today.

[The prepared statement of Mr. Glancey follows:]

CLEAN
FUELS
DEVELOPMENT
COALITION

TESTIMONY OF
MR. JAMES T. GLANCEY
CHAIRMAN, CLEAN FUELS DEVELOPMENT COALITION
BEFORE THE
SENATE ENERGY & NATURAL RESOURCES COMMITTEE
NOVEMBER 14, 1989

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TESTIMONY OF
MR. JAMES T. GLANCEY
CHAIRMAN, CLEAN FUELS DEVELOPMENT COALITION
BEFORE THE
SENATE ENERGY & NATURAL RESOURCES COMMITTEE
NOVEMBER 14, 1989

GOOD MORNING MR. CHAIRMAN AND MEMBERS OF THE COMMITTEE. MY NAME IS JAMES T. GLANCEY, PRESIDENT OF ETHANOL MARKETING, INC. OF BOISE, IDAHO, AND CHAIRMAN OF THE CLEAN FUELS DEVELOPMENT COALITION (CFDC). ON BEHALF OF CFDC, I APPRECIATE THE OPPORTUNITY TO TESTIFY TODAY IN SUPPORT OF ALTERNATIVE FUEL PROGRAMS THAT UTILIZE OXYGENATED FUELS, ESPECIALLY FUEL ETHANOL AND ITS DERIVATIVE, ETHYL TERTIARY BUTYL ETHER (ETBE). MY PURPOSE IN TESTIFYING TODAY IS TO RELAY OUR POSITION ON THIS IMPORTANT ISSUE FROM AN ENVIRONMENTAL, AGRICULTURAL, AND ENERGY SECURITY STANDPOINT.

FIRST, LET ME SAY THAT CFDC IS A TRUE COALITION. OUR MEMBERS REPRESENT THE AUTO INDUSTRY, ETHANOL PRODUCERS AND MARKETERS, ETBE MANUFACTURERS, AGRICULTURE ORGANIZATIONS, AND PUBLIC INTEREST GROUPS DEDICATED TO THE EXPANDED USE OF CLEAN-BURNING MOTOR FUELS. CFDC SUPPORTS THE USE OF NEAT ALCOHOL FUELS (85% BY VOLUME OR MORE), OXYGENATED FUELS SUCH AS ETHANOL AND THE ETHERS IN "REFORMULATED GASOLINE" (AND DIESEL FUEL), COMPRESSED NATURAL GAS (CNG), AND ANY OTHER FUEL OR TECHNOLOGY WHICH CAN REDUCE OZONE, CARBON MONOXIDE, AIRBORNE TOXICS, AND SO-CALLED "GREENHOUSE GASES". CFDC WAS ESTABLISHED IN 1988 TO ENSURE A VITAL ROLE FOR THESE FUELS IN PROPOSED CLEAN AIR LEGISLATION.

AS YOU KNOW, FOR THE PAST TWENTY YEARS, CONGRESS AND VARIOUS ADMINISTRATIONS HAVE GRAPPLED WITH THE PROBLEM OF REDUCING EMISSIONS OF OZONE-FORMING COMPOUNDS AND CARBON MONOXIDE (CO) FROM THE TRANSPORTATION SECTOR, THE SINGLE LARGEST SOURCE OF THESE HARMFUL EMISSIONS. INSOFAR AS VEHICLE EMISSIONS STANDARDS ARE CONCERNED, THE RESULTS ARE NOTHING SHORT OF REMARKABLE: 96% REDUCTIONS IN THE MOST HARMFUL OF THESE VOLATILE ORGANIC COMPOUNDS (VOCS), MOSTLY HYDROCARBONS. THE AUTOMOBILE INDUSTRY, IN COOPERATION WITH THE FEDERAL GOVERNMENT, SHOULD BE COMMENDED FOR PRODUCING THE CLEANEST, MOST EFFICIENT AUTOMOBILES POSSIBLE USING EXISTING TECHNOLOGIES AND FUELS.

However, despite this apparent success, 101 cities remain in non-attainment of National Ambient Air Quality Standards (NAAQS) for carbon monoxide and ozone as set forth under the Clean Air Act. CFDC believes that the answer lies not necessarily with the vehicles or their engines, but with the fuels they use. Therefore, the focus of new legislation should be directed toward improving fuel quality through the implementation of rigorous, national motor fuel standards and specifications, especially regarding the concept of "reformulated gasoline."

The fuel alcohol industry -- both ethanol and methanol-- has been working at it for over a decade. Responding to policy initiatives developed by Congress in the late 1970s, fuel ethanol is now blended in over 8% of the motor fuels sold in the United States. With a production capacity of over 1.1 billion gallons annually, ethanol production consumes about 350 million bushels of corn each year. However, despite this success, fuel ethanol production falls far short of the 10 billion gallon per year target set forth by Congress during the last energy crisis as a matter of national policy for the end of the 1980s.

Overall, oxygenated fuels offer the following benefits:

Reduced Carbon Monoxide Emissions: As is now well-understood and accepted, use of oxygenated fuels in gasoline can significantly reduce carbon monoxide (CO) during winter months.

Reduced Ozone Formation: Oxygenated fuels, whether used neat or in blends with low-aromatics and lower-volatility gasoline, can reduce ozone formation because the fuel is burned more completely. The lower rate of reactivity of oxygenated fuels displaces ozone forming compounds such as butane and aromatics.

Lower Concentrations of Benzene and Aromatics: The aromatic content of gasoline has increased steadily in the 1980s as refiners have responded to EPA lead phase-down regulations and expanded octane demand. Aromatic hydrocarbon emissions from automobiles are highly toxic, especially benzene. Oxygenated fuels can be substituted for higher concentrations of aromatic hydrocarbons in gasoline.

The major expansion of the production and use of ethanol for gasoline blends and as a feedstock for ETBE is justified on policy grounds encompassing agriculture, energy, and the environment. Expanded ethanol and ETBE production in the United States stands on a three-legged policy stool: Air quality, new markets for agriculture, and less dependence on foreign oil. Here lies the major rationale behind the long-standing congressional support for expanded ethanol and ETBE production and use.

The issue for the nation today is air quality, reformulated fuels, and oxygenates -- particularly ethanol and ETBE. CFDC suggests that the proper reformulation of motor fuels cannot be

ACHIEVED WITHOUT ETHANOL AND ETBE. I FURTHER SUBMIT THAT REFORMULATED FUELS WILL NOT MEET A PRUDENT AIR QUALITY TEST WITHOUT A MINIMUM ANNUAL AVERAGE 2.7 WT. PERCENT OXYGEN STANDARD. BOTH FUEL ETHANOL AND ETBE, ALONG WITH MTBE, ARE SUPERIOR MOTOR FUEL COMPONENTS FOR USE IN REFORMULATED GASOLINE.

FACTORS THAT SHOULD DETERMINE MOTOR FUEL QUALITY INCLUDE:

- o DRIVEABILITY AND CUSTOMER SATISFACTION
  - PERFORMANCE
  - MILEAGE
- o ENVIRONMENTAL QUALITY AND POLLUTION REDUCTION
  - OZONE
  - CARBON MONOXIDE
  - AIR TOXICS

EACH OF THESE PERFORMANCE BAROMETERS CAN BE ENHANCED BY THE USE OF OXYGENATED FUELS. THE REFORMULATED FUELS OF THE FUTURE WILL REQUIRE DIFFERENT SPECIFICATIONS IN ORDER TO MEET NEW U.S. PERFORMANCE AND ENVIRONMENTAL STANDARDS. AMONG THEM:

- o HIGH OCTANE
- o LOW VAPOR PRESSURE
- o HIGH OXYGEN CONTENT (2.7 WT. PERCENT YEAR ROUND)
- o LOWER REACTIVITY
- o LOWER TOXICITY (DISPLACES AROMATICS SUCH AS BENZENE)
- o RENEWABLY-DERIVED (RECYCLES CO2, REDUCES GREENHOUSE GAS)
- o DOMESTICALLY-PRODUCED (ENHANCES ENERGY SECURITY, REDUCES BALANCE OF PAYMENTS DEFICIT)

WE THINK THAT ETBE IS A PROMISING FUEL APPROACHING COMMERCIALIZATION THAT MEETS THIS CRITERIA AND IT MAY BE THE BEST LONG TERM APPLICATION OF ETHANOL. A KEY QUESTION TO BE ANSWERED REGARDING ETBE IS HOW MUCH OF IT CAN BE MADE FOR SALE IN THE GASOLINE MARKETPLACE? SINCE ETBE IS MADE AT A REFINERY THROUGH THE REACTION OF FUEL ETHANOL AND ISOBUTYLENE IN THE PRESENCE OF A CATALYST, IT IS NECESSARY TO HAVE PLENTIFUL SUPPLIES OF BOTH FUEL ETHANOL AND ISOBUTYLENE TO MEET ANTICIPATED DEMAND. GIVEN THE ENVIRONMENTAL PROTECTION AGENCY'S (EPA) EXPECTED REGULATIONS TO REQUIRE FURTHER REDUCTIONS IN SUMMERTIME GASOLINE VOLATILITY, THIS WILL GENERATE EXCESS BUTANE -- AN ISOBUTYLENE FEEDSTOCK.

AN EXAMPLE OF HOW A MAJOR ETBE PROGRAM MIGHT TAKE PLACE IS CONTAINED IN APPENDIX A OF MY TESTIMONY.

TO CLEAN OUR AIR NOW, WE PROPOSE THE FOLLOWING "REFORMULATED GASOLINE" STRATEGY, WHICH INCLUDES A "CLEAN FUELS CREDIT" SYSTEM. THESE REFORMULATED FUELS CAN BE USED IN THE EXISTING AUTOMOBILE FLEET WITH GREAT EFFECT, REDUCING THE NEED FOR MORE STRINGENT EXHAUST EMISSION STANDARDS. THIS PROPOSED SYSTEM ALLOWS THE REFINER AND MARKETER TO DETERMINE THE TYPE OF OXYGENATED FUEL BLEND WHICH SUITS ITS INDIVIDUAL NEEDS, WITH A MINIMUM OF GOVERNMENT INTRUSION OR REGULATION.

THIS SYSTEM IS DESIGNED TO EMPLOY THE BEST ELEMENTS OF EPA'S GASOLINE LEAD CONTENT BANKING, TRADING, AND REPORTING SYSTEM WHICH HAS BEEN A PROVEN SUCCESS. THE MAJOR ELEMENTS OF THE PROPOSED SYSTEM ARE:

1. ALL MOTOR FUELS SOLD IN A GIVEN OZONE AND CO NON-ATTAINMENT AREA MUST MEET AN AVERAGE OXYGEN CONTENT (OR EQUIVALENT) REQUIREMENT THROUGH THE SALE OF GASOLINE CONTAINING VARIOUS OXYGENATED FUELS. OTHER FUELS SUCH AS ELECTRICITY AND NATURAL GAS CAN BE GIVEN "OXYGENATE EQUIVALENT VALUES" THEREBY MAKING THEM ELIGIBLE FOR INCLUSION IN THIS ASPECT OF THE PROGRAM;

2. THE AROMATIC CONTENT AND RVP OF FUELS WOULD BE LIMITED, ALTHOUGH REGULATORY FLEXIBILITY ALLOWING AROMATIC CONTENT AVERAGING (SIMILAR TO THAT PROPOSED FOR OXYGENATED FUELS) WOULD BE PERMITTED;

3. THE REQUIRED USE OF PROVEN DEPOSIT-INHIBITING GASOLINE ADDITIVES WOULD REDUCE EMISSIONS, IMPROVE GASOLINE MILEAGE, AND LOWER ENGINE OCTANE REQUIREMENTS;

4. FLEXIBILITY IS PROVIDED TO REFINERS AND MARKETERS UNDER THIS SYSTEM TO SELECT THE TYPE OF OXYGENATED FUEL SUITABLE TO THEIR NEEDS IN A GIVEN MARKETPLACE;

5. GASOLINE REFINERS AND MARKETERS COULD MARKET FUELS CONTAINING LOWER OXYGEN LEVELS PROVIDED THAT THEY OBTAIN "CLEAN FUEL CREDITS" FROM THOSE MARKETERS WHOSE FUELS EXCEED THE AVERAGE OXYGEN CONTENT;

6. ON A YEAR-ROUND BASIS, THE AVERAGE OXYGEN CONTENT FOR FUELS SOLD IN A NON-ATTAINMENT AREA COULD NOT BE LOWER THAN 2.7% (WT.), AN OPTIMUM LEVEL TO ACHIEVE SUBSTANTIAL CO REDUCTIONS;

7. PAPERWORK REQUIREMENTS WOULD BE HELD TO A MINIMUM, UNDER A SYSTEM WHICH RESEMBLES EPA'S LEAD TRADING AND REPORTING SYSTEM; AND

8. THE COSTS OF SUCH A SYSTEM WILL BE SUBSTANTIALLY LOWER TO THE FEDERAL GOVERNMENT, GASOLINE REFINERS AND MARKETERS, AND CONSUMERS THAN ANY OTHER KNOWN CONTROL OPTION WHICH CAN ACHIEVE SIMILAR REDUCTIONS.

THE BENEFITS AND COSTS OF SUCH A PROGRAM ARE PRESENTED IN MORE DETAIL IN APPENDIX B OF MY TESTIMONY. APPENDIX C IS AN ASSESSMENT OF IMPACTS ON THE AUTO INDUSTRY FROM SUCH PROGRAMS AND A COMPARISON OF REDUCTIONS FROM PROPOSED STANDARDS WITH THOSE WE THINK AVAILABLE FROM REFORMULATED GASOLINE .

In conclusion, CFDC believes pursuit of a broad oxygenated fuels policy is sound energy and environmental policy for the United States. We should take a closer look at what we can do to accomplish this initiative most expeditiously.

In terms of what this distinguished committee can do, I respectfully suggest that you continue to support an investment in our nation's future through extension of the tax incentives that are currently in place. A renewed commitment to producing domestic energy may, if nothing else, serve to keep oil prices in check from foreign sources. The tax incentive program that is currently in place is, in our view, an extremely cost effective form of assistance and if it were extended for another ten year period, domestic ethanol production would expand significantly, providing all the benefits I have mentioned here today.

We should strive to improve better industry and government cooperation in a period of rapid fundamental change for the oil industry, and for the international economic challenges faced by the United States. It is my judgment that those companies which choose to mold their business and product development strategies consistent with changing U.S. energy and environmental priorities will be the winners in the political, economic, and customer satisfaction arenas.

Thank you for providing me the opportunity to present the views of the CFDC.

APPENDIX A

5-6 BILLION GALLON ETBE PRODUCTION SCENARIO

1. 250,000 B/D OF N-BUTANE SURPLUS WILL OCCUR AS A RESULT OF GASOLINE VOLATILITY REDUCTIONS FROM 11.5 TO 9.0 LBS. (AN ACCEPTED RULE OF THUMB IS 120,000 B/D OF REFINERY N-BUTANE SURPLUS FOR EACH ONE PSI REDUCTION IN GASOLINE VOLATILITY.) (SOURCE: API PIPELINE CONFERENCE, APRIL, 1988, PHILLIPS PETROLEUM CO).

2. ASSUMING THAT 42 GALLONS EQUALS A BARREL -- THIS SURPLUS WILL BE APPROXIMATELY 10 MILLION GALLONS OF N-BUTANE PER DAY GENERATED BY PETROLEUM REFINERS (NOTE: THIS FIGURE DOES NOT INCLUDE THE N- AND ISO-BUTANES HELD BY THE NATURAL GAS PROCESSING INDUSTRY, OF WHICH SUPPLIES ARE AT LEAST AS LARGE).

3. ASSUME A 1:1 CONVERSION RATIO OF CONVERTING THE N-BUTANES TO ISO-BUTANES BY ISOMERIZATION (ACTUALLY, THE LITERATURE INDICATES THAT ISOMERIZATION ACTUALLY YIELDS MORE ISO-BUTANE THAN A 1:1 CONVERSION), AND A 1:1 CONVERSION OF THE ISO-BUTANE TO ISOBUTYLENE.

4. THIS EQUATES TO 10 MILLION GALLONS PER DAY OF ISOBUTYLENE AVAILABILITY FROM JUST THE SURPLUS N-BUTANES RESULTING FROM GASOLINE VOLATILITY RESTRICTIONS.

5. FURTHER, ASSUMING 360 OPERATING DAYS PER YEAR, 3.6 BILLION GALLONS OF ISOBUTYLENE WOULD BE AVAILABLE PER YEAR FOR REACTION WITH FUEL ETHANOL TO PRODUCE ETBE. THE ETBE REACTION KINETICS ARE:

   1.0 UNITS ISOBUTYLENE + 0.62 UNITS ETHANOL = 1.47 UNITS ETBE

   THUS, IF 3.6 BILLION GALLONS OF ISOBUTYLENE PER YEAR WERE REACTED WITH APPROXIMATELY 2.3 BILLION GALLONS OF ETHANOL, THE TOTAL WOULD BE 5.9 BILLION GALLONS OF ETBE PRODUCED EACH YEAR. (SOURCE: AMERICAN EAGLE FUELS, LINCOLN, NEBRASKA).

APPENDIX B

BENEFITS & COSTS OF A MAJOR ETBE PROGRAM

IF IT BECAME U.S. POLICY TO REQUIRE SIX BILLION GALLONS OF ETBE TO MEET THE REFORMULATED FUEL NEEDS OF THE FUTURE--RESULTING IN LOWER REFORMER SEVERITY, LOWER REFINERY STATIONARY SOURCE EMISSIONS, AND INCREASED GASOLINE YIELDS -- THE FOLLOWING NATIONAL OBJECTIVES WOULD ALSO BE ACCOMPLISHED:

1. MAINTENANCE/ENHANCEMENT OF QUALITY, HIGH-OCTANE FUELS;
2. NO SUBSTANTIAL MOTOR FUEL TRANSPORTATION INFRASTRUCTURE CHANGES;
3. MAJOR ENVIRONMENTAL IMPACTS:

o 65% REDUCTION IN MOBILE SOURCE CARBON MONOXIDE EMISSIONS

o 50% REDUCTION IN EVAPORATIVE AND TAILPIPE OZONE PRECURSORS

o 65% REDUCTION IN MOBILE SOURCE EMISSIONS OF BENZENE AND OTHER AIR TOXICS;

4. NEW HIGHER VALUE PROCESSING MARKETS FOR SURPLUS, LOW-COST BUTANE;
5. SIX BILLION GALLONS OF NEW DOMESTIC HIGH-QUALITY LIQUID FUEL PRODUCTION;
6. ONE BILLION BUSHELS NEW CORN DEMAND (ENOUGH TO OFFSET HARVEST YIELD INCREASES BETWEEN 1990 - 2004);
7. NEW JOBS IN DOMESTIC GAS AND NATURAL GAS LIQUID PROCESSING;
8. REPLACEMENT OF FOREIGN OIL PURCHASES -- INCREASED GASOLINE YIELD;
9. STRONGER DOMESTIC ENERGY AND AGRICULTURE ECONOMY; AND
10. IMPROVED NATIONAL SECURITY, BETTER BALANCE OF TRADE, AND A NEW, "BALANCED" ENERGY POLICY.

ESTIMATED COSTS OF PROGRAM IMPLEMENTATION

THE CAPITAL INVESTMENT COSTS TO PRODUCE ETBE IN THE VOLUMES SUGGESTED ABOVE, WOULD BE APPROXIMATELY $5 TO $7 BILLION. (SOURCE: "U.S. GASOLINE OUTLOOK, 1989-1994," INFORMATION RESOURCES, INC.)

APPENDIX B, P.2

ADDITIONAL REFINERY OPERATING COSTS, AND COST INCREASES TO THE RETAIL GASOLINE CONSUMER WOULD AMOUNT TO ABOUT $2 BILLION PER YEAR, IF CRUDE OIL REMAINS IN THE $18 - $20 PER BARREL RANGE. THIS CHANGE WOULD COST CONSUMERS LESS THAN TWO CENTS PER GALLON AT THE PUMP! HOWEVER, TAXPAYER SAVINGS ON FARM PROGRAMS WOULD MORE THAN OFFSET INCREASED RETAIL FUEL COSTS AS FARM PROGRAM SAVINGS WOULD AMOUNT TO APPROXIMATELY $4 BILLION PER YEAR IN LESS GRAIN STORAGE COSTS, AND LOWER GOVERNMENT DEFICIENCY PAYMENTS TO FARMERS.

MOST OF THE CAPITAL INVESTMENTS WOULD BE AT THE REFINERY, OR IN FIELD BUTANE ISOMERIZATION AND DEHYDROGENATION FACILITIES. MANY REFINERIES ARE ALREADY MAKING THESE CHANGES, WITH ADDITIONAL ETHERIFICATION CAPACITY BEING BUILT, INITIALLY FOR MTBE, BUT ALSO POTENTIALLY FOR ETBE PRODUCTION. TRANSPORTATION, STORAGE, AND DISTRIBUTION CHANGES WOULD BE MINIMAL. THE REQUIRED REFINERY PROCESS AND INVESTMENT CHANGES COULD BE ACCOMPLISHED WITHIN A PERIOD OF AS LITTLE AS 3-5 YEARS.

APPENDIX C

OXYGENATED FUELS AND THE AUTOMOBILE

OXYGENATED FUELS (ETHANOL, METHANOL, AND THEIR ETHER DERIVATIVES), WHEN BLENDED WITH GASOLINE, CAN BRING ABOUT SUBSTANTIAL AND IMMEDIATE IMPROVEMENTS IN AIR QUALITY WITHOUT REQUIRING CHANGES IN THE AMERICAN LIFESTYLE. THE FOLLOWING IS A SUMMARY OF BENEFITS DERIVED FROM SETTING STANDARDS FOR THE USE OF OXYGENATED FUELS.

SUGGESTED GASOLINE STANDARD:

1. A GASOLINE AVERAGE OXYGEN CONTENT OF 2.7% BY WEIGHT IN ALL NON-ATTAINMENT AREAS, ON A YEAR ROUND BASIS;

2. A GASOLINE REID VAPOR PRESSURE (RVP) NOT TO EXCEED 9 PSI; AND

3. A GASOLINE AROMATIC CONTENT NOT TO EXCEED 25%.

RATIONALE:

1. USE OF OXYGENATED FUELS HAVE BEEN DEMONSTRATED TO REDUCE CARBON MONOXIDE (CO) EMISSIONS FROM AUTOMOBILES BY 15% - 25% UNDER REAL WORLD CONDITIONS.

2. EPA HAS DETERMINED THAT USE OF OXYGENATED FUELS REDUCE EXHAUST EMISSIONS OF UNBURNED HYDROCARBONS, AND THUS REDUCE OZONE BY 5% - 15%, FOR THE FOLLOWING REASONS:

   A. HYDROCARBON VOLUMES ARE DISPLACED BY THE PERCENTAGE OF OXYGENATED FUELS USED IN THE FINISHED FUEL.

   B. THE VOLUME OF GASOLINE AROMATICS IS REDUCED BY 25% TO 50% IF THE FINISHED FUEL'S INCREMENTAL OCTANE IS DERIVED FROM OXYGENATES. CURRENTLY, THE OVERALL AROMATIC CONTENT OF GASOLINE, WHICH EXCEEDS 40% BY VOLUME, COULD BE LOWERED TO LEVELS IN THE 25% - 30% RANGE.

   C. OVERALL REACTIVITY OF GASOLINE IS SUBSTANTIALLY REDUCED WHEN OXYGENATED FUELS ARE SUBSTITUTED FOR REFORMATE, OLEFINS, AND TOLUENE.

3. EMISSIONS OF BENZENE, ON THE INCREASE IN RECENT YEARS, WOULD BE SUBSTANTIALLY REDUCED DUE TO THE REPLACEMENT OF AROMATICS WITH OXYGENATED FUELS.

4. HIGH OCTANE, CLEAN-BURNING OXYGENATED FUELS CAN REPLACE GASOLINE OCTANE COMPONENTS WHICH ARE KNOWN TO AGGRAVATE AIR POLLUTION AND HUMAN HEALTH.

APPENDIX C, P.2

A COMPARATIVE ANALYSIS OF EXHAUST EMISSIONS REDUCTION STRATEGIES

POLLUTANT	CURRENT STANDARD	CONGRESSIONAL PROPOSALS[1]	PERCENTAGE REDUCTION	REF. GASOLINE REDUCTIONS[2]
UNBURNED HYDROCARBONS	0.41 GR./MI.	0.31 GR./MI.	25%	20 - 25%
NITROGEN OXIDES	1.0 GR./MI.	0.4 GR./MI.	60%	(UNKNOWN)
CARBON MONOXIDE	3.4 GR./MI.	1.7 GR./MI.	50%	35 - 40%
PARTICULATES (PM_10)	0.2 GR./MI.	0.08 GR./MI.	60%	40%

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[1] FOR LIGHT-DUTY PASSENGER VEHICLES MANUFACTURED BEGINNING IN THE 1993 MODEL YEAR.

[2] REDUCTION BENEFITS ESTIMATED BASED UPON THE FOLLOWING FUEL COMPOSITION:

REID VAPOR PRESSURE:	9 PSI
AROMATIC CONTENT:	NO MORE THAN 25% BY VOLUME
OXYGEN CONTENT:	NO LESS THAN 2.7% (WT.) ON AVERAGE
SULFUR CONTENT:	NO MORE THAN 0.05% (WT.)
ADDITIVES:	AVAILABLE INTAKE AND EXHAUST DEPOSIT CONTROL FORMULAS

NOTE: THESE OR SIMILAR REDUCTIONS CAN BE EXPECTED ACROSS THE ENTIRE MOTOR VEHICLE FLEET, NOT MERELY FOR VEHICLES TO BE MANUFACTURED BEGINNING IN THE 1993 MODEL YEAR.

The CHAIRMAN. Thank you, Mr. Glancey.

Mr. Dietch.

STATEMENT OF ROBERT DIETCH, VICE PRESIDENT, ENGINEERING, PLANNING AND RESEARCH, SOUTHERN CALIFORNIA EDISON CO.

Mr. DIETCH. Good morning. My name is Robert Dietch. I am Vice President of Engineering, Planning and Research for the Southern California Edison Company.

We have submitted a written statement for the record on behalf of my own company, but also for the Los Angeles Department of Water and Power, the Edison Electric Institute and the American Public Power Association.

I appreciate this opportunity to appear before the committee today to discuss our efforts to encourage the use of electricity as a transportation fuel. Improving air quality has become a high priority in our southern California service territories, as I am sure you are aware.

Although more severe than those in other parts of the nation our nonattainment problems are not unique. Parts of the approach devised by our local South Coast Air Quality Management District to deal with the nonattainment issues are unique.

The District's regulatory program would rely heavily on the introduction of low emission motor vehicles over the next 20 years to reduce mobile source pollution. The plan would fundamentally change the southern California transportation system, first by requiring the introduction of increasing numbers of low emission vehicles and ultimately by requiring that all vehicles run on extremely low emission fuels that produce no tailpipe emissions.

Vehicles powered by electricity offer the single best means of making the substantial reductions in mobile source emissions that would be required in southern California.

The results of a recent study by the California Air Resources Board demonstrate that electric vehicles produce substantially less emissions of reactive organic gases, carbon monoxide and nitrogen oxides into gasoline powered vehicles, even when incremental emissions attributable to the generating of the electricity needed for the vehicle recharging are considered.

When the Air Resources Board compared vehicles using electricity as a fuel with other alternative fuels, including methanol, compressed natural gas and liquid petroleum gas, the results confirmed that of the relatively near-term alternatives to conventional gasoline powered vehicles, EVs are by far the lowest emission alternatively fueled vehicle.

From an energy policy and security standpoint, electricity has the dual advantages of available supply and domestic production. Because electric vehicles will be recharged primarily at night, the electricity necessary for charging operations can be generated during the off-peak hours, when plants might otherwise be idle, thereby making more efficient use of our existing generating capacity.

Further the Electric Power Research Institute has concluded that substitution of electric vehicles for each 1 percent of the vehicles currently registered in the country would save approximately 35 million barrels of oil per year and reduce our trade deficit by $1 billion annually.

The idea of using electricity as a transportation fuel is certainly not new to this committee. Since at least the mid-1970s substantial federal and private resources have been devoted to research and development of electric vehicles.

As our written statement explains, despite the documented advantages of electricity as a motor vehicle fuel, electric vehicles are not commercially available today. Our company has made a commitment to change that. We participate in a number of programs in California to advance the commercialization and use of electric vehicles.

One such undertaking, called the Los Angeles Initiatives seeks proposals from manufacturers to introduce 10,000 electric vans, trucks and passenger cars to the south coast air basin by 1995. Southern California Edison is a member of the California Electric Vehicle Task Force, which is composed of state energy regulatory agencies and major utilities.

The Task Force has recently endorsed a California plan for the commercialization of electric vehicles, which lays out for the first time a set of specific actions and associated funding needs for commercializing electric vehicles over the next 10 years.

We are also active in the Department of Energy's ongoing electric vehicle program through its Site Operator's Users Task Force.

On the national level, we are working with the Los Angeles Department of Water and Power, Edison Electric Institute, the American Public Power Association to increase public awareness and understanding of the benefits of electricity as a transportation fuel.

We have backed our support for electric vehicles with a substantial financial commitment. We are in the process of completing a purchase of 15 pre-production electric G-Vans. There are full-size vans based on the General Motors Vandura body design, capable of transporting passengers or cargo.

We will be demonstrating the electric G-Vans to interested fleet buyers in Southern California, as well as loaning the vehicles to fleets for testing on day-to-day operations. We believe that offering fleet managers practical experience with these vehicles will encourage commercial orders for the 1990 production model G-Vans.

In addition we have arranged with Potomac Electric Power here in Washington, D.C. to bring the G-Van here this week for an extended loan period.

I hope that you or your colleagues will have an opportunity to ride and drive in this vehicle to see firsthand the progress that is made in developing electric vehicle technology. Senator McClure, in fact, has already driven one of these G-Vans.

In the coming months our company will continue its efforts to develop and promote electricity as a transportation fuel. We are convinced that the use of electricity as a transportation fuel will play a major role in resolving the nation's long-term air quality concerns.

We urge Congress to include electricity in any legislation concerning alternative fuels. The efforts already underway within the private sector must be complemented by a renewed federal policy commitment to electric vehicles.

And I would just add, we know that electric vehicles are not the total solution, the one solution. We do think there are many solutions to this problem. Electric vehicles do have a niche in there.

Thank you.

[The prepared statement of Mr. Dietch follows:]

STATEMENT OF ROBERT DIETCH
VICE PRESIDENT OF ENGINEERING,
PLANNING AND RESEARCH FOR
SOUTHERN CALIFORNIA EDISON COMPANY
ON BEHALF OF THE
LOS ANGELES DEPARTMENT OF WATER AND POWER,
EDISON ELECTRIC INSTITUTE AND
THE AMERICAN PUBLIC POWER ASSOCIATION

Before the
Senate Committee on
Energy and Natural Resources

November 14, 1989

Good morning. I am Robert Dietch, Vice President of Engineering, Planning and Research for the Southern California Edison Company (SCE). We at SCE appreciate the Committee's continuing interest in alternative fuels, and I am grateful for this opportunity to address the need for energy and environmental policies that encourage wider use of electric vehicle technologies.

My comments today are also offered on behalf of the Los Angeles Department of Water and Power (LADWP), the Edison Electric Institute and the American Public Power Association. For several months we have been engaged in efforts to increase public awareness and understanding of the benefits of electricity as a transportation fuel. Our joint efforts signify the commitment of the electric utility industry as a whole to the advancement of electric vehicle technologies.

Priority attention is being given to air quality issues in nonattainment areas of the country, such as SCE's and LADWP's southern California service territory. The serious problems facing southern California in its effort to attain air quality standards, as well as regulatory approaches under development within the state to deal with these attainment issues, are well known. SCE is seeking to assure that electric vehicles (EVs) are included as part of any air quality attainment program directed toward mobile sources.

Our company is active in a number of specific efforts to advance the commercialization and use of electric vehicles. Among others, we participate in the California Electric Vehicle Task Force. The Task Force was created in 1988, and includes representatives from state agencies, including the Air Resources Board, Air Quality Management Districts, the California Energy Commission, and the California Public Utilities Commission as well as utilities to bring a balanced perspective to policymaking concerning the role that electric vehicles have in California's transportation future. The Task Force is charged with advancing the development of EV technologies, with particular emphasis on selected research, development and demonstration efforts. Most recently, the Task Force has endorsed "A California Plan for the Commercialization of Electric Vehicles." This plan sets forth the first set of specific actions and associated funding needs for commercializing electric vehicles over the next ten years.

One other important effort to encourage the introduction of electric vehicles is known as the Los Angeles Initiative, a joint request for proposals developed by the LADWP, other Los Angeles City Offices and SCE. The Initiative seeks proposals from manufacturers to introduce 10,000 electric vans, trucks and passenger cars to the South Coast Air Basin by 1995.

Seven finalists have been selected from among nineteen proposals received in response to the Los Angeles Initiative. A decision on the firms to proceed to the contract negotiation stage is expected to be made later this fall.

Several concerns and interests motivate the electric utility industry's support for EVs. Widespread use of electric vehicles would provide a market opportunity for off-peak power sales. Since electric vehicles would be recharged primarily during the overnight hours of nonpeak use of electricity, more efficient utilization of electrical generating capacity would be achieved.

But it is not solely this prospect of load levelling that attracts the electric utility industry to this technology. Several utilities have participated in the development and proof-of-concept of today's EV technologies, in part through the Site Operators User Task Force program of the Department of Energy's Electric and Hybrid Vehicles Program. Electric utilities are expected to be among the initial purchasers and users of electric vehicles when commercial production is initiated.

SCE has already made a substantial financial commitment to electric vehicles. We are in the process of completing a purchase of 15 pre-production models of the most advanced electric vehicle technology now available, the Electric G-Van. In the coming months, we will be demonstrating the Electric G-Van to interested fleet buyers in southern California, as well as loaning the vehicles to fleet operators for testing in day to day operations.

We will continue our efforts to develop and promote electricity as a transportation fuel. We are convinced that the use of electricity as a transportation fuel must play a major role in resolving the nation's long term concerns about pollution from mobile sources. The industry believes that public policy should embrace increased reliance on EV technology as an effective means to attaining air quality standards, particularly in urban areas.

For all these reasons, we are pleased to offer this statement to update the Committee on the need for electric vehicles and to make recommendations that will place appropriate emphasis on electric vehicle technologies.

Principles Underlying Past Electric Vehicle Policy

Efforts to encourage the development of electric vehicle technologies have been part of our national energy policy at least since the passage of the Electric and Hybrid Vehicle Research, Development and Demonstration Act in 1976. However, for a variety of reasons, the ambitious objectives of that Act have yet to be realized. This is partly attributable to the broad scope of EV technology development requirements, and to the reduced demand for alternatives to petroleum-based fuels produced by the drop in world oil prices.

Energy policy considerations primarily led to the Federal government policy of support for electric vehicles in the mid-1970's. Today both the need for a long-range energy policy based upon secure domestic resources and the increased public policy focus on air quality issues provide the impetus for a re-examination of the role that electrically-powered vehicles should play in our nation.

In this process, it is important that very significant energy policy issues not be wholly overshadowed by environmental concerns. Electric vehicle technologies are, however, one of the unique technologies that can offer substantial contributions in both the environmental and energy policy arenas. For this reason, federal policy should encourage the development of electric vehicles.

Environmental Benefits Of Widespread Electric Vehicle Use

The Environmental Protection Agency (EPA) reported in late July of this year that 101 metropolitan areas in this country do not meet National Ambient Air Quality Standards (NAAQS) for ozone, based on data collected in 1986-1988. For carbon monoxide, 44 areas are not in compliance with existing NAAQS. Emissions from roadway vehicles -- cars, trucks and buses -- have been identified as a primary cause of non-attainment of air quality standards for ozone and carbon monoxide.

Renewed commitments to attaining ozone and carbon monoxide standards create new opportunities for clean-fueled transportation alternatives. Electric vehicles must play a central role in any program designed to address emissions from mobile sources because they are the single most effective means of reducing transportation sector emissions.

According to the Electric Power Research Institute (EPRI), replacement of just one percent of the vehicles registered in the United States today with electric vehicles would reduce emissions by 160,000 tons per year from what they would otherwise be. The California Air Resources Board (CARB) recently published emission rates for several alternative fuels -- electricity, methanol, compressed natural gas (CNG) and liquid petroleum gas (LPG) -- and comparisons of the emissions produced by alternatively-fueled vehicles to those of gasoline-powered vehicles in three categories -- reactive organic gases (ROG), carbon monoxide and nitrogen oxides. The results demonstrated that of the relatively near-term alternatives to conventional gasoline powered vehicles, EVs not only offer the greatest reduction in emissions when compared to gasoline-powered vehicles, but are by far the lowest emission alternatively-fueled vehicles.

As illustrated in Attachment 1, when compared to gasoline, electric vehicles are 64 times better in terms of emissions of reactive organic gases, 174 times better in terms of carbon monoxide emissions and 8 times better in terms of oxides of nitrogen emissions. The CARB results factor in the incremental emissions attributable to generating the electricity required to recharge the electric vehicles. The CARB figures also demonstrate how much lower EV emissions are than those of other alternative fueled vehicles. For example, in emissions of reactive organic gases (ROG), EVs are 55 times better than methanol, 32 times better than LPG and 30 times better than CNG.

Concern is also being raised about carbon dioxide (CO_2) and its possible contribution to global warming. In southern California, recharging EV batteries would produce 45 percent less CO_2 than would the continued use of gasoline-powered vehicles. (Source: SCE Engineering, Planning and Research Department.)

Energy Security Benefits of Widespread Electric Vehicle Use

Electric vehicles also offer important benefits in terms of energy security. Replacement of gasoline-powered vehicles with EVs could displace large amounts of imported oil. The Office of Technology Assessment has found that 39 percent of U.S. oil consumption is attributable to light duty vehicles, including automobiles, vans and light trucks. According to EPRI, substitution of electric vehicles for each one percent of the vehicles currently registered in this country would save approximately 35 million barrels of oil per year and reduce our trade deficit by $1 billion annually. The substitution of conventionally-fueled vehicles with electric vehicles offers one important means of insulating the national economy from the shocks occasioned by any disruption in the oil marketplace.

Alternative Fuels Programs As Part Of Clean Air Proposals

The South Coast Air Quality Management District (AQMD) in southern California has proposed a plan that has received considerable national attention. Once fully approved, the plan would be implemented in three stages ("tiers"). Full implementation of already known control technologies is to take place over a five year time frame (Tier I). As part of this measure, new requirements for the purchase of "low emission" vehicles are being drafted to affect light duty fleet vehicles as early as 1993.

In Tier II of the AQMD plan, significant advancement of today's technologies will be required over the next ten years. Use of low emission vehicles will be mandated for 40 percent of all passenger vehicles, 70 percent of all freight vehicles and for 100 percent of transit vehicles currently powered by diesel fuel. The AQMD's assumption is that to meet the air quality requirements established for Tier II, 50 percent of all the newly introduced low emission passenger vehicles called for under the plan will have to be electric vehicles: that is, 1.7 million EVs in California alone by the year 2000. Meeting this target will require the production and sale of 350,000 EVs per year in the period 1995-2000.

In Tier III, technological breakthroughs occurring over the next twenty years will be relied upon to require conversion of all vehicles to "extremely low emission fuels" which produce no tailpipe emissions. At the present time, electric vehicles are the only vehicles that would satisfy this "extremely low emission fuels" requirement. Again, the AQMD's underlying assumption is that to achieve Tier III requirements will require at least 70 percent of the new extremely low emission passenger vehicles to be electric vehicles: a total of 6.7 million EVs in California by the year 2010. The production and sale of 500,000 vehicles on average will be required in each year between 2001 and 2010 to meet this target. It is understood that full compliance with the AQMD plan may ultimately require an all-electric transportation system in the 21st century.

At the federal level, all of the significant legislative proposals under consideration in the context of the Clean Air Act debate recognize that converting to clean-fueled alternatives from gasoline-powered vehicles is central to attaining air quality standards, particularly in urban areas. Differing approaches have been offered to address the need to get more clean-fueled vehicles on the road, particularly in severe non-attainment areas of the country. Some of the approaches mentioned range from the President's proposal to progressively introduce clean-fueled vehicles in ever increasing numbers in the period between model years 1995 and 2004, to Representative Waxman's legislation (H.R. 2323) to establish requirements for sales of certain minimum percentages of low-emission vehicles using clean fuels to serve as a baseline for air quality compliance strategies in severely polluted areas.

It is imperative that any alternative fuels programs that may be adopted by the Congress treat electric vehicles fairly. As a matter of federal policy, we should not rule out any of the alternative clean fuel vehicles currently under discussion, or place any additional obstacles in the way of their development.

Existing Barriers To Commercialization Of Electric Vehicles

Despite years of technology development efforts, *e.g.*, efforts concentrating substantial public and private resources on battery research, development and improvement, electric vehicles for highway use are not commercially available today. A number of barriers that prevent this technology from reaching its full potential can be identified. Some of these barriers are market-based, while others are technical. Some barriers may be regulatory, and still others may best be characterized as "public relations" problems. Congress should take the initiative now to augment efforts already underway in various states and within the private sector to advance the prospects for electric vehicle use.

Market-Based Barriers To Electric Vehicles

The convergence of energy and environmental issues in the growing national debate on clean air presents an important opportunity for electric vehicles. The most logical introductory markets for EVs are in those urban areas of the country where attainment of air quality standards is most difficult, where the environmental benefits of EVs would have the greatest impact, and where the operational limits of EVs are acceptable. Replacement cycles and procurement practices provide a means to introduce EVs into existing fleets as older conventionally-powered vehicles are retired without disruption to the overall fleet. Because of their low maintenance requirements and low energy costs, EVs present an attractive alternative to currently available fleet vehicles.

Today, no market-driven demand for electric vehicles exists. Two factors that hamper the development of an EV market are high initial vehicle cost and inability to evaluate EV performance in actual driving conditions. Moreover, certain infrastructure issues also remain to be resolved if an EV marketplace is to develop.

° High purchase price: To date potential EV manufacturers and fabricators have been unwilling to make the investments necessary in facilities for the high-volume production of electric vehicles without stronger indications of consumer demand for EVs. As a result, only a few proof of concept or prototype vehicles have been made available in this country. The lack of production facilities has kept the per vehicle cost high compared to comparable gasoline-powered vehicles. Without volume production, which is expected to achieve significant economies of scale and thereby lower costs, consumers will resist paying the high purchase price per vehicle.

- Lack of experience with EV performance: Without volume production, consumers are unable to evaluate the performance of EVs in actual on-the-road-use, and are unwilling to commit to the use of a large number of EVs until they are satisfied that EV performance characteristics are acceptable and that the vehicles will be cost competitive on a life cycle basis with conventionally-fueled vehicles.
- Infrastructure issues: Supporting the introduction of a new vehicle technology will require a number of consumer service-oriented steps. Creation of an initial distribution network is required, and must be carefully planned to assure that EVs are available in those areas of the country where they can make the largest contribution to attaining air quality standards. Although EV maintenance costs are expected to be substantially less than those of conventional vehicles, service networks still will need to be established. Also, provisions for recharging need to be developed, in conjunction with the electric utility industry. Given the existing electricity distribution infrastructure, providing for recharging is not expected to be a significant burden.

Technical Barriers To Electric Vehicles

Much of the unrealized promise of the electric vehicle development programs of the 1970's and early 1980's may be attributed to the continuing need for electrical drivetrain improvements. EV supporters concede that performance improvements are needed, particularly with regard to battery development. Nevertheless, public policymakers at all levels must recognize that proven EV technology is available, and that millions of miles have been driven in electric vehicles all over the world. The task facing us now is to get the available technology on the road -- to build a performance history that will convince consumers and manufacturers alike of the benefits of EVs and to identify areas where technological improvements would have the most impact.

- Technical limitations on vehicle range: The electric vehicles closest to the point of commercialization today are powered by conventional lead-acid batteries. While the lead-acid battery configuration has been shown to be highly reliable, the battery pack must be periodically replaced during the life of the EV, which significantly affects the life cycle cost of the vehicle. With the lead-acid technology, a full sized electric van has been designed, is in prototype production, and is undergoing Federal Motor Vehicle Safety Standards (FMVSS) tests. Current EVs powered by lead-acid batteries are capable of a 60 mile range between recharging, which is suitable for many urban fleet applications. In fact, as many as 40 percent of commercial light duty fleet vehicles in major urban areas travel only 60 miles in any given work day. However, near term technology, i.e., technology expected to be available within the next five years, will rely on nickel-iron and sodium sulfur batteries, that will increase the projected electric vehicle range to as much as 150 miles between recharges. Such a range can meet the daily needs of the vast majority of drivers of passenger cars and light duty vans and trucks in the United States. Early electric vehicles equipped with lead-acid batteries can be refitted with advanced batteries when they become available. Nevertheless, the existing limitations on vehicle range make it essential that an initial niche market -- urban fleets -- be developed for the introduction of EVs, and that improvements in vehicle range be achieved before EV technology will be acceptable to a broad spectrum of consumers.

- Other performance concerns arising from the need for improved battery technologies: Improvements in battery technology resulting in improvements in vehicle performance are essential to the ultimate commercial acceptance of electric vehicles. Increased investment in battery R&D is required. Yet investment in battery research is effectively stymied today by the lack of commercial prospects for electric vehicles. An important outgrowth of developing an EV market would be the creation of an outlet for improved EV battery products. Then a market-driven mechanism would exist to pull private R&D funds into battery research, and thereby advance the time when enhanced battery technologies will be commercially available.

Regulatory Barriers

Under the Alternative Motor Fuels Act of 1988, an interagency study of regulatory barriers to electric vehicles is underway. The final study report, including recommendations for additional regulatory incentives, is to be sent to Congress this fall. We are hopeful that the study will identify important opportunities for action, and that Congress will move promptly to consider legislative responses.

In our own examination of this issue, we have found instances of a lack of equal treatment of incentives offered, for example, to alcohol fuels but not to electric vehicles. As this study progresses, it will be important to emphasize the need for an improved regulatory playing field for electric vehicles, so that their development is not artificially impeded by lack of incentives or outright regulatory barriers. We look forward to a thorough analysis of the regulatory framework at the federal government level that will provide the basis for the development of further policies to encourage electric vehicle development.

The "Perception" Barrier

When officials of our company have discussed EVs with federal and state officials, it is clear that electric vehicles are fundamentally misunderstood. Currently available technology -- the Electric G-Van -- is a full-sized van capable of transporting passengers or cargo. Electric G-Vans come equipped with automatic transmissions, power steering and air conditioning. A description of the G-Van is presented in Attachment 2.

Unfortunately, when people think of EVs, the image produced is one of golf carts, or perhaps the triangular, one-passenger commuter cars seen in the late 1970's in some of our cities. The industry has moved far beyond those fledgling attempts, but some of the problems encountered with the early technologies still seem to overshadow efforts to encourage wider use of much-improved EV technologies today. We still find that in the list of alternative vehicle fuels, electricity is often given little recognition or omitted entirely, despite its comparative benefits vis-a-vis other fuels.

Recommendations for Congressional Action

It is very important for the federal government to send a strong signal that EV technology is important and worthy of public and private sector interest, involvement and investment. To realize the benefits offered by electric vehicles, Congress should adopt an initiative to facilitate the early introduction of electric vehicles in urban areas. Such an initiative would serve both as a means to lessen the air quality impacts of the transportation sector and to reduce our national reliance on imported petroleum. As stated earlier, replacement of just one percent of the vehicles registered in the U.S. today with electric vehicles would reduce emissions by 160,000 tons per year and save 60,000 barrels of oil per day.

The advantages of EVs described above -- their contribution to a cleaner environment and greater national and economic security derived from greater energy security -- currently relate more to "general public benefits" than to benefits likely to be realized by individual consumers of electric vehicles. Unless or until consumers are convinced that the product meets their individual needs, or until public policy dictates a change in consumer habits, EVs, despite their public benefits, are not likely to displace conventionally-fueled vehicles.

Quite obviously, public policy is in transition. As increasing emphasis is placed on attaining air quality standards, the anticipated changes in environmental policy are likely to dictate changes in consumer choices for transportation. Those alternately fueled vehicles which best meet consumer preferences and are most able to cost-effectively comply with new public policy dictates will have the best chance of market acceptance. The benefits of EVs -- the technology most consistent with the need to reduce mobile source emissions; the technology able to provide the most direct and effective means to cutting transportation sector emissions -- cannot be realized soon unless consumer acceptance is also addressed and accelerated.

A Federally-Supported Program To Promote The Commercialization of Electric Vehicles Is Justified

The federal government must make a commitment to an EV commercialization effort as soon as possible, to get today's available technology on the road in order to realize the benefits EVs offer in terms of environmental improvement and energy security enhancement. Commercial applications of EVs in actual driving conditions will demonstrate the capabilities of the technology, thereby increasing consumer acceptance and making real progress toward the ultimate goal of commercialization. In light of the rapidly changing focus of public policy toward achieving the air quality objectives of the Clean Air Act, and to insure that EVs are available to achieve those goals, the federal policy focus should be expanded to address directly the obstacles to widespread commercial use of EVs.

The type of initiative needed to address the problem of consumer acceptance has a parallel in the automotive industry: "seeding" the market with a new product. Through "seeding," the market is shown the product, enabling consumers to become familiar with it and leading to improvements in the product. For electric vehicles, a multi-year, federally funded production incentive program is needed. Such a program would send a clear signal to the marketplace -- EV producers and potential consumers -- that this nation recognizes electric vehicle technology development and demonstration as a key element of energy and environmental policy. The magnitude of the benefits offered make it appropriate to devote public funds -- properly leveraged by substantial private commitment -- to an electric vehicle commercialization program.

Federal efforts to support EV commercialization should include, at a minimum:

- A requirement for vehicle purchase cost sharing between private and public sector participants, with limitations on the percentage of the per vehicle cost that may be paid by federal funds;
- A program targeted to those non-attainment areas with the most significant need for air quality improvement;
- An effort directed not to ultimate purchasers but to potential manufacturers, in order to develop a continuing manufacturing capability and to address directly the problem of high initial electric vehicle cost. Responsibility for marketing the EV product should be the vehicle manufacturer's, not the government's;
- Administration of the program through the Department of Energy, building on its established expertise, with appropriate consultation with the Departments of Transportation and Commerce and the EPA;
- A multi-year authorization, to provide stability in the program and to permit the integration of advanced battery technologies and other technology improvements into a commercially acceptable vehicle or vehicles; and

- An ultimate goal of driving down the cost of EVs, calculated on a life cycle basis, to be on a parity with the life cycle costs of a comparable conventionally fueled vehicle.

Congress should also act to provide new regulatory incentives for electric vehicle technology development as well. For example, in the area of procurement policies, a requirement that the federal government purchase electric vehicles where appropriate would also offer a clear sign of the federal government's commitment to realizing the energy security and environmental benefits of EVs, and lessen the perception of economic risk to potential EV purchasers.

Conclusion

High vehicle costs, as well as lack of actual on-the-road experience, have kept EV demand below the level necessary to justify manufacturers' investment in production facilities. Without carefully designed incentives, EVs will continue to be produced in only very small numbers at prohibitive costs. Unless a program to spur commercialization is instituted, this nation will continue to be denied the primary benefits of EVs: reduced vehicle emissions and reduced reliance on foreign energy sources.

As the chairman of the California Energy Commission observed in testimony before the Subcommittee on Energy Research and Development in June, a national effort "is important to show the economic potential to the private sector for developing new cleaner fuel technologies. This is particularly true for technologies that require significant research and development such as electric vehicles and battery technology. . . ." The federal government can and should assume a leadership role in encouraging electric vehicle production and advancements in the technology to the point where the benefits of this technology -- expressed in environmental and energy security terms -- can begin to be realized.

Attachment 1

California Air Resources Board
1989 Emission Comparison

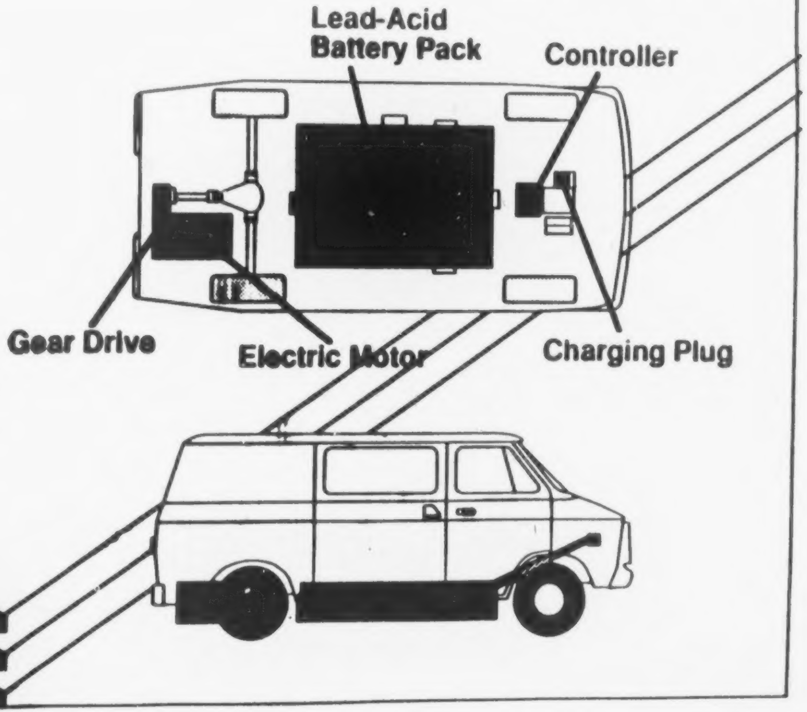
Grams/Mile Emission Results

Vehicle Type	*ROG*	*CO*	*NOX*
Gasoline	0.39 *Electric is 64 times better*	1.40 *Electric is 174 times better*	0.66 *Electric is 8 times better*
Methanol	0.34 *Electric is 55 times better*	1.00 *Electric is 124 times better*	0.45 *Electric is 5 times better*
LPG	0.20 *Electric is 32 times better*	1.40 *Electric is 174 times better*	0.27 *Electric is 3 times better*
CNG	0.19 *Electric is 30 times better*	0.10 *Electric is 11 times better*	0.44 *Electric is 5 times better*
Electricity	0.006	0.008	0.07

Attachment 2

G-Van Specifications

Gross Vehicle Weight -
Cargo and Passenger
8,600 lbs.
Full-Size GMC Vandura
Ground Clearance 7 inches
DC Electric Motor (52 hp,
216 volt, 43kW)
Lead-acid Battery (216 volt,
205 ampere-hours)
Power Brakes and Steering
One Speed Gear Drive
Auxiliary Battery


Lead-Acid
Battery Pack
Controller
Gear Drive
Electric Motor
Charging Plug

The CHAIRMAN. Thank you very much, Mr. Dietch.

The last time I focused on electric cars was during the energy crisis. And since that went away, I personally have not looked at it again. I was just looking through your statement.

You say that with new batteries you can go 150 miles with an electric vehicle.

Mr. DIETCH. The range—the range is right now—the first G-Van that we are proposing is a 60-mile range vehicle. We have that—that has a definite niche. There is about—40 percent of the commercial van vehicles in the Los Angeles area are, in fact, drive 60 miles or less in a day.

Our next vehicle is a Chrysler T-Van. And the T-Van has a 120 mile range. And we—100 to 120.

The CHAIRMAN. You say your next vehicle.

Mr. DIETCH. Once we start getting over—the next vehicle, which we have ordered and will be getting the prototype in early 1990.

The CHAIRMAN. And that uses what kind of batteries?

Mr. DIETCH. That uses the iron chloride.

The CHAIRMAN. Are those batteries, the iron chloride and the sulfur—sodium sulfur, are those going to be expensive batteries?

Mr. DIETCH. Oh, yes. The first—the prototypes are very expensive. And that is part of our problem, is to get a production. First we need a market, then we need a production facility, which can get the prices down, just like any marketing product. It is new. It is behind most of the other technologies we are talking about, and therefore we believe needs a little more support than the other technologies.

The CHAIRMAN. It seems to me that we were talking about a gallium arsenide battery at one time.

Mr. DIETCH. At one time. We have not been dealing with it today.

The CHAIRMAN. Do you see anything on the horizon for a cheap high density energy battery that will make electric cars more attractive?

Mr. DIETCH. We are working on—besides the two you have mentioned, Senator, we are working on one with Jet Propulsion Laboratory as I recall, which is a very high power density battery. If we can bring it off, it would be even better than the other two we have mentioned.

So we keep working. It is a research and development areas that is going to continue and needs continued support in order to—I do not know what the ultimate range of a batteried vehicle would be. But there could be, for instance, a battery vehicle with power assist as well to extend the range if you want.

We are also working—and they are going to put in a pilot roadway, which will have a buried cable, which would be a constant charging capability. It is the electrified roadway. We are putting—we are talking about putting one in in the west side of L.A., in which you would—as you are driving you would be able to charge just from the underground cable.

The CHAIRMAN. What is the speeds that you can get now with an automobile?

Mr. DIETCH. The speed on the G-Van that we are producing or buying is a 52 mile an hour top speed. The speed on the Chrysler

T-Van that we talked about getting in early 1990 is a 70 mile an hour with the 120 mile range. So that is a much—that is quite a leap.

The CHAIRMAN. How about the pick-up?

Mr. DIETCH. The pick-up on the G-Van is not tremendous. Senator McClure drove it, and he could attest to that. The pick-up on the T-Van—the T-Van will have a two-speed transmission. The G-Van is really a single-speed.

The CHAIRMAN. All right. Mr. Strang, you talked about fleet need to come in with fleet specifications, particularly buses. Would you mandate a retrofit of buses?

Mr. STRANG. Not necessarily, Senator. I think the important thing is that we recognize that those mobile sources are making those large contributions.

I think the phase-in program will certainly be acceptable. We need to learn more about the integrated systems, as we are now working with Flexible Bus Corporation and those engine manufacturers.

We are learning that and will understand better by the end of this coming summer of July 1990 on how those first 10 buses operate.

The system should be in our judgment optimized. You should have an engine matched to a fuel. And in that particular case, some phase-in process would be helpful. But identifying specific emission levels as low level as is possible really help drive that market.

The CHAIRMAN. Mr. Vaughn, would you speak about ethanol versus reformulated gasoline in terms of clean-up costs?

Mr. VAUGHN. Yes, sir. I could—we could probably spend much of the rest of the day talking about ethanol and clean air, and I can give you a number of specifics, and studies and analysis, reports and specific reductions.

As even Mr. Dickinson from ARCO said, we do not know much about ARCO's EC-1. We do not know what reformulated is. We can probably extrapolate. I would assume that EPA could extrapolate on what the benefits would accrue to a reformulated product at various concentrations of, let us say oxygen.

If you reduced xylenes by 15, maybe 10 percent, 15 percent, increase the level of oxygenated fuel to about a three or three-one standard, you could easily achieve minimal standards of carbon monoxide reductions of 30 percent. And you could achieve, probably, ozone reductions in the range of 5 percent to 8 percent. That is a simple reformulation. You can obviously get much more complex.

Ethanol will clearly help you with carbon monoxide and ozone. It depends on what you need to do with the air toxics and the aromatics with regard to impact on ozone, further increases in ozone.

The CHAIRMAN. Mr. Strang, I understand that three pipe lines are coming to the Los Angeles area in about two-and-a-half years. Is that correct?

Mr. STRANG. Well, there are some competing proposals before FERC for additional pipeline capacity into the state of California. The schedule on when those would be approved is uncertain. But that time frame is probably reasonable, the one that you described.

I would like to make a comment about capacity, because it was mentioned previously by another member of another panel. We are supplying in the southern California area high level service to existing customers.

To put it in perspective, 25 percent of our total requirements go to power generation for electric power. We do not burn coal in the state. And we have a minimal amount of use of other fuels. Within that limit, there was a mention of curtailment.

There has been a small amount of curtailment in terms of the total requirements required by the electric power generating facilities. But we have met on the order of 82 percent of that. And that whole market was established for them to utilize alternate fuels when necessary.

Clearly there are demands on the electric power generating side to utilize more natural gas. And we welcome them as a good customer. They are our biggest customer now. But there are additional capacity opportunities that we are pursuing right now.

We have capacity additions of 200 million cubic foot a day on the drawing board and could be completed within a year's time, if gas can be brought in from El Paso, natural gas, at the receipt point where we receive gas at the California/Arizona border.

My understanding is that El Paso could have clearance on that additional capacity by April of 1990. And then as soon as that is true, we would proceed with additional 200 million a day capacity requirements within our own existing system. That capacity would be over and above any other capacity that would be provided by out-of-state, other pipeline systems.

The CHAIRMAN. How would it move toward fleet use of natural gas affect the price of natural gas?

Mr. STRANG. I cannot say precisely. But I think when we looked at the numbers in our particular case, we do not see a dramatic astronomical change in the total overall amount of gas that would be consumed.

To utilize one figure in my testimony, for the entire nation, if we had 8 million to 10 million vehicles—and that is a significantly large number—there would be a total increase in natural gas requirements of 6 percent over the existing annual consumption today.

Our look at these initial niche markets for fleet vehicles say that something in the order of 1 percent or so would be additional capacity requirements or additional fuel requirements to serve those markets for the next few years.

As far as price is concerned, I think it is pretty much a price demand issue. Natural gas prices have inflated at a lower rate than gasoline. And our guess is that that might well continue.

The CHAIRMAN. Mr. Myers, is there a supply of LP gas in L.A. basin and elsewhere to go to fleet use of LP gas?

Mr. MYERS. Yes, Mr. Chairman. We have done extensive studies on that in cooperation with the California Energy Commission, as well as the South Coast Air Quality Management District.

The supplies that are available from the domestic refineries as well as what comes from the naval petroleum reserve at Elk Hills, and the traditional imports that come out of state—for instance, some comes from Arizona, the Four Corners area—there is adequate supplies to do more than 1.5 million vehicles in California itself.

And the Air Resources Board has confirmed that and accepts that premise.

The CHAIRMAN. You talk about use of LP gas for buses, cars and trucks. Most experience with cars and trucks indicates that the owners use them for a period of years, maybe three years and then sell them.

What would this do to the market for used LP cars and trucks? LP gas cars and trucks?

Mr. MYERS. Well, most of the truck fleets probably are in the 5 or the 7-year turnover range of the passenger cars would be something similar, probably as you suggest, in the 3-year, 3-year range.

We see a scenario, if I may divert here for a second into the Rule 1601 proposed by the Air Quality Management District in southern California, which would in fact mandate the fleet conversions is that, if in fact a—either a factory-converted CNG or LPG vehicle was retired from one fleet, the sheer fact that that vehicle is available in the market may well assist a fleet purchaser to buy that used vehicle so he gets up to his 10 percent mandate.

We see a scenario downstream where the fact that an alternative fuel vehicle running on LPG, for example, may even command a premium in the resale market rather than the penalty that it currently experiences.

The CHAIRMAN. I have a letter here referred to earlier from Clayton Yeutter, the Secretary of Agriculture. I want to put it in the record.[1]

Senator McCLURE. Thank you very much, Mr. Chairman.

I appreciate the testimony of each of you. And I guess one of the best ways to summarize what happens in this committee in a hearing like this is, there are a lot of potential answers out there. We have to try to sort through them and come up with the right kind of a mix.

I think there is a great temptation to mandate a single program. And if I understand each of you, you are saying do not do that. Make it a competitive field in which a lot of alternatives can be tried. If I understand you correctly, while you each have your own point of view with respect to one alternative, none of you are asking us to mandate a single solution to the problem.

And I appreciate that. Because I think many years ago Congress went the other direction with respect to tailpipe emissions and automobiles and mandated the catalytic converter as the single strategy. It did not quite say that, but it had that result.

And we may have stifled some other alternatives as a result of that action, as prudent as that action may appear, and as much good as it brought.

But I, for instance, you know, Mr. Dietch, that I drove an electric automobile for a year here and found that it has some shortcomings. But it is still suitable to use. And the next generation, which you are talking about, it will be even more useable for the average commuter.

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[1] See Appendix to this document for Secretary Yeutter's letter.

Certainly, the thing that we look at most is the fleet use, delivery vans, things of that nature where the economics are very, very positive. And the difficulties are not quite so apparent as would be in expecting the average citizen to buy and operate an electric vehicle. I am still very strongly in favor of electric vehicles. And I commend you for what you are doing.

Obviously, too, I support the ethanol option, an ETBE. I hate to see the idea promoted anywhere. They were going to run a series of tests that will drive future policy that does not include the several alternatives that are apparent. I have forgotten the exact figure, but I think we are now importing over half of our petroleum fuels most of the time now.

Headlines over the last couple of weeks—the Japanese are buying Manhattan. Well, I suppose the Indians did not care whether it was the Japanese or the Dutch who did it. But we as a nation are concerned about foreign opportunities to purchase facilities, real estate, factories within our own country.

And there is only one ultimate answer to that. And that is to stop buying as much from overseas and start selling more. You cannot possibly have the imbalance in the balance of payments that we have today, and have had chronically for the last several years, without building up currency reserves in foreign countries.

And those currency reserves are going to be expressed in one way or another. And perhaps the least damaging result is purchasing facilities, re-investing that capital inside our country.

Americans are not used to that. But we are somewhere on the order of $150 million a day on the imports of foreign petroleum, foreign energy supplies. It seems to me prudent, as we look at the options for our country, that we not make that problem worse, but recognize it exists and try to do something in future fuel availability that reduces the demand for imports.

One of the concerns I have about methanol is that, if we do not do something about it, methanol will probably be supplied from foreign sources. I am not sure that does much good for our economic problems in this country. And we have to consider that economic problem, as we look at the solutions, we ought to be trying to create in our country.

Mr. Glancey, I think you and others know that over 40 years ago, I used an alcohol injector on my automobile to do precisely what people are today trying to do. And that is increase the octane rating.

I told the story many times, but it bears repeating, because as we moved the lead out of the gasoline, the result was predictable. It was absolutely predictable. And those people who are now wringing their hands over the fact that aromatics were used to produce octane had to know that was the necessary and calculated result of taking the lead additives out of gasoline.

And so we created one problem as we solved another. I hope we are wise enough now to recognize that governmental actions have consequences. And instead of wringing our hands about the new problems, let us try to solve those problems without creating the next round of problems.

And I very strongly believe that if we can move towards ethanol, whether it be as a neat fuel, or a blend, or ETBE, that we have done something for the domestic economy in rural America as well. And we spent over $20 billion a year on farm programs.

If we can get alternative markets, we do not have to do that. We got 30 million to 35 million acres of land in this country, we are paying the owners to idle. We are paying them. It is a cost to us. Not just a loss in production, it is a direct cost to every taxpayer.

Now if we could convert some of our transportation fuels to using materials, renewable materials in our own country that could be produced on the farms, we do not have to maintain that kind of a farm program.

We seem to compartmentalize our views. It is either an energy question, or it is a farm problem, or it is an environmental question, or it is a foreign trade question. We do not seem to have the means by which we bring together all of these various facets and try to forge a policy that answers each of them, instead of creating more problems, creating more solutions.

I appreciate your testimony. You have all given us reason to try to develop a diverse—not a mandated fuel, but a mandated result—and allow the various forms of energy to contribute their part of the solution to those several problems.

But I hope you will never get total tunnel vision here, and forget that energy policy affects other policies. I am very struck by the testimony we received in the panels today. And I thank each one of you for your contribution to it.

With that, the committee will stand adjourned.

Thank you very much.

[Whereupon, at 12:10 p.m., the hearing was adjourned.]

APPENDIX

RESPONSES TO ADDITIONAL QUESTIONS

Department of Energy
Washington, DC 20585

February 28, 1990

The Honorable J. Bennett Johnston
Chairman, Committee on Energy
  and Natural Resources
United States Senate
Washington, DC 20510-6150

Dear Mr. Chairman:

I appreciated the opportunity to appear before the Committee on Energy and Natural Resources on November 14, 1989, concerning alternative transportation fuels.

Enclosed, please find replies to questions you asked us to address for the hearing record. I trust you will find these responsive to the Committee's concerns.

Sincerely,

Linda G. Stuntz

Linda G. Stuntz
Deputy Under Secretary
Policy, Planning and Analysis

Enclosure

QUESTIONS FROM SENATOR JOHNSTON

Question 1: The LPG witness, Mr. Myers, testified that in 1987 the U.S. produced 19 billion gallons of LP gases. He predicted 4 billion additional gallons per year could be produced in the U.S. by 2004, excluding Alaskan North Slope production. Mr. Myers concluded that when Alaskan LPG and Canadian supplies are counted, the U.S. could operate 8-10 million vehicles on LPG.

Do you agree with these figures? For how long would we have an adequate North American supply? What effect would this transportation use have on the price and availability of LPG currently going to chemical and other markets? Please also answer for supply and price of natural gas if CNG competed in this niche.

Answer: Domestic production of liquid petroleum gases (LPG) in 1987 was estimated by the Energy Information Administration (EIA) to be 1.75 million barrels per day (mmb/d). Adding net imports of 0.15 mmb/d and subtracting 0.3 mmb/d input to refineries, LPG supplied to the domestic market was 1.6 mmb/d, or 24.7 billion gallons. For 2004, the EIA base case supply projection is 2.12 mmb/d, or 32.5 billion gallons, which represents a projected increase of 7.8 billion gallons over 1987. EIA projections include Canadian LPG imports, which are not separately forecast. Alaskan LPG supplies are not included since EIA classifies these as crude oil.

Answer 1 Continued:

We estimate that ten million LPG vehicles would use approximately 8.7 billion gallons of LPG per year. For the year 2000, this would increase projected LPG demand by 28 percent. This increase in demand would be met by increased LPG imports, increased domestic production, and some reduction of LPG use by petrochemical and other users of LPG who would turn to petroleum based feedstocks and distillate fuel oil.

Increased LPG production would, in turn, require either increased production of natural gas or increased use of oil for LPG production in petroleum refineries. Since increased LPG demand would not, in itself, cause corresponding increases in natural gas production, most increased LPG supplies that are provided to satisfy increased LPG demand would be derived from petroleum or come from imports.

Ten million CNG vehicles would use approximately 506 billion cf of natural gas per year. For the year 2000, this would increase projected U.S. natural gas demand by 2.5 percent. This increase in demand may be met by increased domestic, Canadian supplies, or other imports of natural gas.

Answer 1 Continued: We have no basis for providing reliable estimates of the impact of increased demand for either LPG or CNG on feedstock (crude oil and natural gas) prices. Because 10 million CNG vehicles would increase total domestic natural gas demand by a comparatively small amount, the effect on natural gas prices can be presumed also to be relatively small. Estimating the price effect of 10 million LPG vehicles is significantly more complex; it would require, for example, determining how much flexibility refiners have in increasing LPG yield, and what incremental costs would result.

Question 2: Would a rapid conversion to LPG of the light duty fleets and mass transit buses in the nine target cities improve air quality? By how much? How about CNG?

Answer: The Department of Energy does not have estimates of the degree to which urban air quality would be improved by using LPG or CNG in light duty vehicles or urban transit buses. We defer to the answers provided to you by the Environmental Protection Agency (EPA).

Question 3: **There is currently a nine cent per gallon Federal highway tax on propane. We are exporting butane to South America right now. Shouldn't we be encouraging the use of LPG as a motor fuel in the U.S.? Would reducing the federal tax on LPG have a significant impact on encouraging the fuel for fleet use?**

Answer: As we indicated in the answer to Question 1, the United States has been and is likely to remain a net LPG importer. While there may be periods when we export LPG components like butanes, this is largely due to seasonal changes in the refinery use of certain components and to short-term imbalances as refineries adjust to changes in gasoline characteristics. Increased transportation use of LPG could provide a market for these short-term surpluses of butanes, but no long-term net reduction in oil use is likely.

Reducing the Federal highway tax on LPG is unlikely to have any significant effect on its use. It would have only a small effect on the retail price of LPG, and would not reduce the cost of vehicle conversions or increase the number of retail outlets, which are the real obstacles to greater use.

Question 4: What alternative fuel represents the best combination of energy security, environmental benefits (for production and burning of the fuel), long term availability, and costs?

Answer: No single conventional or alternative fuel can be said to possess the best combination of energy security, environmental benefits, long-term availability, and reasonable cost. In submitting the President's Clean Fuels Program to Congress, the Administration left the determination of which fuels would satisfy that program to the market, consistent with fuel neutral performance standards established by the EPA Administrator.

DOE is evaluating technical, economic, and policy aspects of different alternative fuels. This evaluation would support the EPA Administrator's implementation of the President's proposed Clean Fuels Program and the activities required by the Alternative Motor Fuel Act, including those of the Interagency Commission on Alternative Motor Fuels.

Even when our current studies are completed, it is unlikely that a single fuel will emerge as the "best" fuel. Economic, environmental, and international market conditions will continue to change, as will U.S. requirements for

Answer 4
Continued:

transportation fuels. As a consequence, prudent national policy should establish conditions allowing competition to take place among fuels and technologies.

Question 5:	Could the U.S. displace its entire requirement for leaded gasoline with an unleaded reformulated gasoline that also removes sulphur, most aromatics, and butane, adds ethers to oxygenate the fuel and meets an 87-89 octane requirement? In what time frame? Are there any resource problems? What about domestic refining capacity? What measure of benefit would this provide for air quality?
Answer:	Leaded gasoline currently accounts for about 500,000 b/d, or less than 10 percent, of gasoline demand. The volume of leaded gasoline sold has been decreasing rapidly over the past few years as the older cars and trucks designed for leaded gasoline disappear due to fleet turnover. The amount of leaded gasoline sold in the future will depend in part on consumer demand and in part on the economics of supplying and retailing a low volume product. While a precise estimate cannot be made it is reasonable to assume that on the order of 5 percent of gasoline sold in the next few years will be leaded or a product that fills that market niche.

Although the specific characteristics of a reformulated gasoline to replace "leaded gasoline" are not defined at this time, we can assume that a product similar to that referred to in your

Answer 5
Continued:

question would be likely. Although the Department of Energy has not conducted a study of the U.S. production capability for such a product, the following general observations are possible:

- If such a product is limited to 5 percent of the gasoline market - a likely level of "leaded gasoline" sales in the next few years - the refinery industry as a whole should not have major difficulty supplying such a product. The recent actions by Arco, Sun Oil and others are examples of this capability.

- Small refiners will be affected to the greatest extent. Currently, most leaded gasoline is produced by small refiners. The capital investments to remove sulfur and to make the other changes required to produce an unleaded reformulated gasoline may be prohibitively large for those small refiners. Some might go out of business with an associated loss in U.S. refinery capacity.

Answer 5
Continued:

- The most likely resource problem would be the supply of methyl-tertiary butyl ether (MTBE) or ethel-tertiary butyl ether (ETBE) to be added to the new gasoline. The two possible causes of this problem are (1) the growing demand for MTBE in unleaded gasolines to raise octane levels as butanes are removed (due to RVP requirements) and (2) limits on current isobutylene production capacity. Isobutylene is needed to produce MTBE and ETBE. DOE has not quantitatively analyzed either of these issues and we do not know if these would, in fact. be limiting factors for the production of the small amount of reformulated gasoline proposed by this question.

- DOE has not made an estimate of the likely air quality benefits. Such benefits would depend on
  - the actual formulation of the gasoline,
  - the amount of leaded gasoline displaced, and
  - the vehicles' response, in terms of exhaust and evaporative emissions, to the reformulated gasoline. This information is

Answer 5
Continued:

not available at this time. The first and second year results from the ongoing oil/auto industry reformulated gasoline test program may provide some of the needed information.

Question 6: Is there enough butane available domestically on an annual basis for feedstock for MTBE and ETBE to be able to oxygenate U.S. gasoline stocks to the maximum extent permitted under EPA waivers for MTBE and ETBE?

Answer: Currently 90,000 b/d of MTBE is produced as an octane enhancer and an oxygenate for motor fuel. The Department of Energy has not specifically studied the question of butane availability for a situation in which all gasoline would contain the maximum level of oxygenates. Nonetheless, a rough estimate can be made of the required butane. If all of the approximate 7 mmb/d of gasoline were to contain the maximum level (15%) of MTBE, about 1 mmb/d of MTBE would be required. Since it takes between .8 and .9 gallons of n-butane to make 1 gallon of MTBE, 800,000 to 900,000 b/d of n-butane would be required.

Current refining operations consume about 500,000 b/d of butanes (including isobutane and related butane compounds) for the production of gasoline. Most of the butanes come from internal processing of crude oil; some is purchased from gas processing plants. Lowering the RVP level of gasoline may result in a reduction in butane use

Answer 6 Continued:

and thus produce 100,000 to 200,000 b/d of "excess" butane that would then be available for MTBE production. Therefore an increase of 600,000 to 800,000 b/d production of butane from other sources would be required to provide enough butane for the use of MTBE in all gasoline. A similar situation would exist for ETBE.

Greater production of butane associated with natural gas is one possible source of additional butane. However, the current production of about 300,000 b/d would have to be tripled to provide 600,000 b/d of additional butane needed, and a market would have to be found for the co-produced natural gas. Imports of butanes are another possible source. Meeting the required level would require a six to eight-fold increase in imports.

However, we do not believe that it is necessary to oxygenate all gasolines at substantial cost because oxygenated fuels need not be used in all areas of the country, or be used over the entire year, to achieve environmental goals. Oxygenated fuels are primarily beneficial in reducing carbon monoxide concentrations. Carbon monoxide is a

Answer 6 Continued:

localized and seasonal problem in 44 urban areas consuming an estimated 25 percent (based on population) of the total U.S. gasoline consumption. The use of MTBE and ETBE in this more limited, but more effective, application would create far less of a problem in terms of butane availability.

Question 7: **Are the alcohol fuels (methanol or ethanol) compatible with the North American distribution and marketing infrastructure? Could alcohol fuels be transported through existing crude and products pipelines? What modifications and increased capacity, if any, would be needed? What would be the capital costs?**

Answer: There is a difference of opinion among experts in the area as to the compatibility of the current gasoline distribution system with methanol and ethanol. The two issues of most concern are materials compatibility and water contamination. While it is technically possible to adapt the current distribution system to methanol or ethanol, it may be uneconomic to do so until the volume of alcohols shipped increases to levels similar to these of other products shipped in the system.

For this reason, in DOE's Assessment of Alternative Fuel Use, it was assumed that alcohol fuels would be handled separately, in dedicated equipment (including storage facilities, tank trucks, underground storage tanks at the retail outlet, and dispensing pumps). Some of this equipment would have been converted from gasoline use, but much of it would be newly added to handle

Answer 7 Continued:

the higher volume of alcohol fuels necessary to provide the same energy as gasoline. We also have assumed that methanol will reach the distribution terminal by tanker or barge, and not by pipeline.

For a 1 mmb/d displacement, DOE estimates the following storage and distribution facilities requirements: 41 million barrels of methanol storage at marine terminals and 7 million barrels for the storage of gasoline to be blended into M85; 3600 additional tank trucks for the transport of M85; and 91,000 service stations with facilities to dispense methanol. Conversion and addition of terminal equipment is estimated to cost $500 million; additional tank trucks would cost $200 million; and underground storage tanks (made of carbon steel or specially formulated fiberglass) and methanol-compatible fuel dispensers will cost $4.1 billion, for a total cost of $4.8 billion. This infrastructure could also be used to distribute ethanol. However, if this infrastructure were installed only to distribute ethanol, some existing gasoline tanks could be converted to use ethanol. However, this would not likely lead to significantly different

Answer 7 Continued: cost estimates.

It should be noted that 8% of all gasoline is blended with ethanol (to produce gasohol - 90% gasoline and 10% ethanol) at the rack (final wholesale point) and distributed through existing service stations without difficulty.

Question 8: **What would be the domestic capital costs of requiring sufficient MTBE and/or ETBE production to oxygenate U.S. gasoline stocks to the maximum extent permitted under EPA waivers?**

Answer: The Department is unable, at this time, to estimate the capital requirements to produce enough MTBE and/or ETBE to the maximum extent allowed. This estimate depends on several factors that would require extensive study before it could be completed. These factors include the availability of N-butane and isobutylene from current refinery operations; whether a number of small MTBE plants, co-located with refineries, or a fewer number of large plants are built; and the amount of imported methanol, MTBE, ethanol, ETBE, or isobutylene which would be available.

Question 9: Please comment on a hypothetical clean fuels mandate that would require 25 percent of the Administration's proposed ultra-clean or Phase II fuel to be produced from domestic coal as in the case of methanol. What if the mandate required that fuel production could not result in any increased greenhouse gas emissions? What would be required to accomplish that?

Answer: A requirement that 25 percent of the clean fuels used to satisfy the President's Clean Fuels Program be produced from coal would be inconsistent with the fuel-neutral aspect of the Administration's proposal. We would oppose any legislative requirement that coal-derived methanol (or any other alternative fuel) satisfy a specified percentage of the program.

Our data shows that coal-derived methanol is likely to be significantly more expensive than methanol derived from natural gas. If a plant were built today to produce methanol from coal, the methanol would cost about 75 cents per gallon, compared to methanol produced from natural gas at between 30 and 40 cents per gallon. It is not possible to project with any degree of reliability whether methanol from coal would be economic in the future.

Answer 9 Continued: The lowest cost-method to produce methanol from coal involves the co-production of electricity and methanol (using a process referred to as "once-through" methanol). Methanol costs could be reduced to about 55 cents per gallon using this technology which is not economic. This is also the best technology with which to reduce, but not eliminate, carbon dioxide emissions from coal processing. However, co-production of methanol and electricity depends on the use of coal gasification as an electric generating technology.

We do not estimate that either coal to methanol or coal to electricity and methanol plants would be developed, deployed and be economically competitive in the time frame of the President's "Phase II" program, which would commence in 2000 and last through 2004.

Answer 9 Continued:	A mandate that methanol be derived from coal, without increasing greenhouse gases, would require that all of the coal-derived methanol be produced by converting existing coal fired electricity generating plants to coal gasification, combined cycle generators using "once-through" methanol technology. But, as stated above, it is not clear that this technology would be competitive.

J. BENNETT JOHNSTON, LOUISIANA, CHAIRMAN

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United States Senate
COMMITTEE ON
ENERGY AND NATURAL RESOURCES
WASHINGTON, DC 20510-6150

December 15, 1989

Ms. Linda G. Stuntz
Deputy Undersecretary for
 Policy, Planning and Analysis
U.S. Department of Energy
1000 Independence Avenue, S.W.
Washington, D.C. 20585

Dear Ms. Stuntz:

I would like to thank you for your appearance at the hearing held by the Committee on Energy and Natural Resources on November 14, 1989, concerning the implications of a switch to alternative transportation fuels contained in the President's Clean Air proposal, and its impact on energy policy.

In order to assist the Committee in its consideration of this issue, I am attaching additional questions for inclusion in the hearing record. I would appreciate your sending your responses to Jim Bruce of the Committee staff by January 17, 1990.

Again, thank you for your testimony. I look forward to receiving your additional comments.

Sincerely,

J. Bennett Johnston
J. Bennett Johnston
Chairman

QUESTIONS FROM SENATOR JOHNSTON
FOR DOE

1. The LPG witness, Mr. Myers, testified that in 1987 the U.S. produced 19 billion gallons of LP gases. He predicted that 4 billion additional gallons per year could be produced in the U.S. by 2004, excluding Alaskan North Slope production. Mr. Myers concluded that when Alaskan LPG and Canadian supplies are counted, the U.S. could operate 8-10 million vehicles on LPG.

   Do you agree with these figures? For how long would we have an adequate North American supply? What effect would this transportation use have on the price and availability of LPG currently going to chemical and other markets? Please also answer for supply and price of natural gas if CNG competed in this niche.

2. Would a rapid conversion to LPG of the light duty fleets and mass transit buses in the nine target cities improve air quality? By how much? How about CNG?

3. There is currently a nine cent per gallon Federal highway tax on propane. We are exporting butane to South America right now. Shouldn't we be encouraging the use of LPG as a motor fuel in the U.S.? Would reducing the federal tax on LPG have a significant impact on encouraging that fuel for fleet use?

4. What alternative fuel represents the best combination of energy security, environmental benefits (for production and burning of the fuel), long term availability, and costs?

5. Could the U.S. displace its entire requirement for leaded gasoline with an unleaded reformulated gasoline that also removes sulphur, most aromatics, and butane, adds ethers to oxygenate the fuel and meets an 87-89 octane requirement? In what time frame? Are there any resource problems? What about domestic refining capacity? What measure of benefit would this provide for air quality?

6. Is there enough butane available domestically on an annual basis for feedstock for MTBE and ETBE to be able to oxygenate U.S. gasoline stocks to the maximum extent permitted under EPA waivers for MTBE and ETBE?

7. Are the alcohol fuels (methanol or ethanol) compatible with the North American distribution and marketing infrastructure? Could alcohol fuels be transported through existing crude and products pipelines? What modifications and increased capacity, if any, would be needed? What would be the capital costs?

8. What would be the domestic capital costs of requiring sufficient MTBE and/or ETBE production to oxygenate U.S. gasoline stocks to the maximum extent permitted under EPA waivers?

9. Please comment on a hypothetical clean fuels mandate that would require 25 percent of the Administration's proposed ultra-clean or Phase II fuel to be produced from domestic coal as in the case of methanol. What if the mandate required that fuel production could not result in any increased greenhouse gas emissions? What would be required to accomplish that?

Senator Johnston Questions of December 15, 1989

Question 1

Would a program that combined universal use of a reformulated gasoline, fleet use of CNG and/or LPG, maximum practicable reduction of evaporative and running losses, and increased CAFE standards have a significant effect on air quality? Please quantify the necessary improvements for each of these factors.

Response

The maximum practicable control of evaporative and running losses would produce significant air quality benefits. EPA has announced its intention to promulgate such rules and all the Clean Air Act proposals include such requirements. The use of CNG and/or LPG in fleet vehicles would produce air quality benefits, but their size could be quite small. The benefits of the other two programs are less clear.

Of course, the urban air quality benefits of using CNG or LPG in fleet vehicles would depend on a number of factors such as the emission standards such vehicles would have to meet, how many fleet vehicles actually used the new fuel, etc. The benefit of using CNG or LPG in fleet vehicles would be maximized with dedicated CNG or LPG vehicles. This restricts the fleets able to purchase such vehicles to those which can fuel their vehicles exclusively from company-owned refueling stations, as well as to those fleets which keep their vehicles throughout their useful lives, since no public resale market would exist. In addition, most provisions for the use of alternative fuels in fleets in various Clean Air Act proposals limit fleet purchase requirements to 50 percent or less of new vehicles purchases, since higher purchase requirements may either restrict model availability or result in higher unit production costs for auto manufacturers due to poor economies of sale. Thus, even those larger fleets may account for approximately 10 percent of all vehicle miles travelled, the fact that a fleet program would only affect a portion of new vehicles purchased by those fleets that are centrally-fueled, it is likely that such a program would result in about 3 or 4 percent reduction in VOC emissions in a given urban area.

Assuming equivalent emission control systems to those in use with gasoline vehicles today, dedicated light-duty CNG vehicles are projected to have 80-93 percent lower VOC emissions than their gasoline counterparts meeting the emission standards contained in the President's Clean Air Act proposal.

Dedicated heavy-duty CNG vehicles are projected to have 93-96 percent lower VOC emissions than their gasoline counterparts and 67-80 percent lower VOC emissions than their diesel counterparts. All of these figures are taken from drafts of EPA's special reports on CNG use in vehicles, which are currently undergoing peer review. But, for the reasons given above, these large per vehicle emission reductions, if only applied to a limited number of fleet vehicles, would not have a large impact on overall urban air quality.

Use of LPG would likely yield less benefit than CNG because of the somewhat greater reactivity of the predominant VOC species emitted. EPA will be developing quantitative estimates for the emissions benefits available through the use of LPG in a report to be released later this year.

The maximum practicable control of evaporative and running loss emissions involve both vehicle and fuel changes. The vehicle modifications practicable are addressed in a Notice of Proposed Rulemaking recently signed by Administrator Reilly and the benefits after full implementation have been estimated to be a five percent reduction in total VOC emissions. The bulk of the potential fuel modification is achieved by EPA's proposed Phase II RVP controls (9 RVP in EPA class C areas), which were also a part of the President's proposal (an 8 percent VOC decrease).

The benefits of universal use of reformulated gasoline are difficult to project. However, we can provide the following information on the "per vehicle" effect. One of the potential aspects of reformulated gasoline known to reduce VOC emissions, lower RVP, was already discussed in the previous paragraph. Another, higher oxygen content, could reduce exhaust VOC emissions on a per vehicle basis by another 4-5 percent. This would reduce total VOC emissions for a vehicle meeting the emission standards contained in the President's proposal by 2-3 percent.

Other gasoline reformulations such as lower aromatic and olefin contents, less heavy ends, etc., are still being investigated by both EPA and industry. Their effect on total VOC emissions and ozone reactivity is not precisely known. Quantitative projections must await the availability of more data, though to the best of our knowledge, most vehicles currently in the fleet could use some form of reformulated gasoline, which has the potential for significant near-term emissions reductions.

Finally, tighter fuel economy standards would have little, if any, effect on urban air quality. EPA's emission standards are the same (mass per mile) regardless of vehicle fuel economy.

Question 2

Is there potential for the formation of formaldehyde from the use of neat ethanol or ethanol blends as alternative fuels? How about from the addition of ethers (MTBE and ETBE)?

Response

While there are almost no data on formaldehyde levels from the use of high-level (e.g., 85%) or neat ethanol as a motor vehicle fuel, some initial California Air Resources Board data on one vehicle suggest there is some potential for increased formaldehyde exhaust emission levels compared to gasoline vehicles. The amount of formaldehyde emitted would be less than that emitted from use of high-level or neat methanol in the same or a similar vehicle.

However, one would expect increases in acetaldehyde (the two-carbon aldehyde corresponding to ethanol which has two carbons just as the one-carbon formaldehyde corresponds to methanol which has one carbon) with high-level or neat ethanol compared to gasoline vehicles. The California Air Resources Board data mentioned above suggest an increase of about 50 mg/mile. Another complicating factor to consider in determining acetaldehyde increases with ethanol-fueled vehicles is any change in photochemically-formed acetaldehyde from hydrocarbons. A certain fraction of ambient acetaldehyde emissions may be formed photochemically from hydrocarbon oxidation; this fraction would decrease with decreases in hydrocarbons from ethanol-fueled vehicles.

Of course, overall tailpipe emissions are a function of both engine-out emissions and the emission control system utilized. There would be an increase in engine-out emissions of acetaldehyde with the use of neat ethanol, and possibly an increase in engine-out formaldehyde as well. But since aldehyde emission control would be a priority with ethanol vehicles, emission controls could be tailored for maximum control of these emissions. A good emission control system optimized for aldehyde reduction should control acetaldehyde and formaldehyde emission to levels similar to those of today's gasoline vehicles.

Perhaps the most important point to make about acetaldehyde is that while it is a potential human carcinogen, its estimated potency is only about 6% that of formaldehyde.

Even though the amount of formaldehyde and acetaldehyde may increase with use of high-level or neat ethanol, the amount of other air toxic emissions such as benzene, 1,3-butadiene, polycyclic organic matter (POM), and gasoline refueling vapors would be significantly reduced. Thus, as with methanol-fueled vehicles, there would be a significant overall air toxics benefit with use of high-level or neat ethanol.

Limited emission data indicate that formaldehyde levels are increased by about 50% with MTBE and gasohol compared with gasoline in current gasoline vehicles. Limited data also suggest about a 100% increase in acetaldehyde with 10% ethanol blends. Emission data for ETBE do not yet exist, but increases in formaldehyde and acetaldehyde emissions with ETBE are expected to be similar to the increases seen with 10% ethanol blends. Significant decreases are expected in benzene emissions with use of all of these blends due to both reductions in exhaust hydrocarbons and, probably more importantly, fuel aromatics content. Decreases are also expected in other air toxic emissions. EPA is presently running emission tests to quantify these emission changes.

Question 3

EPA is working toward requiring lower Reid Vapor Pressure (RVP) to reduce the amounts of volatile organic compounds evaporating into the air. I understand that aromatic compounds called xylenes are also highly photoreactive smog precursors. Will lowered RVP reduce the amount of xylenes going into the air or must another approach address that problem?

Response

Lower gasoline RVP levels will cause a slight reduction in xylene emissions. However, xylenes are relatively heavy compounds and are not a major constituent of evaporative or running loss emissions (i.e., those emissions most effected by RVP). Most xylene emissions come from the exhaust. The only known method to reduce xylene exhaust emissions without reducing the emissions of all exhaust VOC constituents is to reduce the xylene content of gasoline at the refinery.

Question 4

How low an RVP in gasoline can be attained without causing reduced safety or cold starting problems? What would be the optimal RVP, taking into account costs and benefits?

Response

EPA has performed an analysis in support of its proposed Phase II RVP control which call for RVPs of 9.0, 7.8 and 7.0 psi in Class C, B and A areas, respectively. These levels appear cost effective and should present no driveability or safety problems. Extrapolating from that analysis, EPA believes that levels as low as 8 RVP in Class C areas (and levels below 7.8 and 7.0 RVP in Class B and A areas, respectively) provide satisfactory driveability and safety. We have not determined whether such levels provide cost effective VOC control.

Question 5

Please estimate the quantity of air toxics emitted from domestic petroleum refineries. Please specify the amount for each air toxic that concerns EPA. For any aromatic compounds, please specify by type.

Response

In order to respond to this question, data from the 1987 Superfund Section 313 emissions inventory were extracted for the Standard Industrial Classification (SIC) 29 (see table). This classification refers to petroleum refineries and related operations. Emissions estimates are presented for only those substances on the list of hazardous air pollutants included in S. 1490. Aromatic compounds are indicated with an asterisk.

These emissions estimates do not represent exact figures for this industry because the SIC code is generically defined, the data is two years old and the emissions estimates, as reported to EPA by the facilities, incorporate some uncertainties. Although the accuracy of some of these estiamtes may be poor, these data provide a valid air toxics emissions profile for this industry.

All Toxic Chemical Release Inventory
1987 Submissions in the Toxic Release Inventory System
Standard Industrial Classification Code = 29

	CHEMICAL	TOTAL AIR RELEASE (lbs/year)
	FORMALDEHYDE	464,709
	CARBON TETRACHLORIDE	291,580
	METHANOL	3,233,028
	ACETONE	0
*	BENZENE	12,281,095
	ETHYLENE	34,312,501
	HYDROGEN CYANIDE	1,399
	CARBON DISULFIDE	384,722
	1,2-DICHLOROPROPANE	62,470
	METHYL ETHYL KETONE	83,000
	1,1,2-TRICHLOROETHANE	16,834
	TRICHLOROETHYLENE	0
	ACRYLIC ACID	13,277
*	4,4-ISOPROPYLIDENEDIPHENOL	4,150
*	NAPHTHALENE	917,829
*	QUINOLINE	6,000
*	BIPHENYL	61,707
*	O-XYLENE	811,757
*	CUMENE	483,790
*	ETHYLBENZENE	3,507,746
*	STYRENE	408,207
*	P-XYLENE	3,952,120
*	P-PHENYLENEDIAMINE	0
	EPICHLOROHYDRIN	0
	1,3-BUTADIENE	161,133
	1,2-DICHLOROTHANE	1,933,952
	ETHYLENE GLYCOL	1,499,642
	METHYL ISOBUTYL KETONE	322,928
*	M-XYLENE	1,825,771
*	TOLUENE	6,672,044
*	CHLOROBENZENE	0
*	PHENOL	24,450
	DIETHANOLAMINE	69,936
*	DI(2-ETHYLHEXYL) PHTHALATE (DEHP)	250
	1,4-DIOXANE	250
	TETRACHLOROETHYLENE	0
	HYDRAZINE	11,201
	CARBONYL SUFIDE	0
	1,2-DICHLOROETHYLENE	250
*	CRESOL (MIXED ISOMERS)	21,865
*	XYLENE (MIXED ISOMERS)	6,763,372
	ASBESTOS (FRIABLE)	9,296

METHYL TERT-BUTYL ETHER	3,036,444
LEAD	71,816
MANGANESE	4,799
MERCURY	0
NICKEL	7,208
ANTIMONY	1,257
ARSENIC	81
BERYLLIUM	0
CADMIUM	0
CHROMIUM	803
COBALT	559
HYDROCHLORIC ACID	2,499
HYDROGEN FLUORIDE	1,566,996
AMMONIA	16,410,108
PHOSHORUS (YELLOW OR WHITE)	0
SELENIUM	22
CHLORINE	26,168
ANTIMONY COMPOUNDS	932
ARSENIC COMPOUNDS	0
BARIUM COMPOUNDS	97,500
CADMIUM COMPOUNDS	0
CHROMIUM COMPOUNDS	44,100
COBALT COMPOUNDS	19,181
COPPER COMPOUNDS	0
CYANIDE COMPOUNDS	0
GLYCOL ETHERS	0
LEAD COMPOUNDS	29,778
MANGANESE COMPOUNDS	3,111
MERCURY COMPOUNDS	0
NICKEL COMPOUNDS	9,771
SELENIUM COMPOUNDS	

Question 6

How does this [air toxics emitted from domestic petroleum refineries] compare to the air toxics emitted by mobile sources in the U.S.? Please specify the amount for each air toxic.

Response

The air toxics impact from motor vehicles is about half of the total air toxics impact. While we do not have estimated emissions of pollutants in tons per year, we do have the estimated annual cancer impacts. This impact is much greater than that from petroleum refineries.

Summary of Risk Estimates[a]

Motor Vehicle Pollutant	U.S. Cancer Incidences/Year[b] 1986
Diesel Particulate	178 - 860
Formaldehyde	46 - 86
Benzene	100 - 155
Gasoline Vapors	17 - 68
Other Gas Phase Organics	
1,3-Butadiene	236 - 269
Acetaldehyde	2
Gasoline Particulate	1 - 176
Dioxins	ND[c]
Asbestos	5 - 33
Vehicle Interior Emissions	ND
Cadmium	<1
Ethylene Dibromide	1
Total:	586 - 1650

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[a] The risk estimates are 95% upper confidence limits.

[b] The risk estimates for asbestos, cadmium and ethylene dibromide are for urban exposure only. Risks for the other pollutants include both urban and rural exposure.

[c] ND=Not Determined.

NOTE: The risk estimates are upper bound estimates; therefore, they are not intended to represent actual numbers of cancer cases but rather can be used to rank the mobile source pollutants and to guide further study.

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RECEIVED JAN 17 1990

January 12, 1990

The Honorable J. Bennett Johnston
Chairman, Committee on Energy and Natural Resources
United States Senate
Washington, D.C. 20510-6150
ATTN: Mr. Jim Bruce

Dear Senator Johnston:

ARCO Products Company is pleased to respond to the questions on reformulated gasoline and other alternative transportation fuels posed by yourself and Senator Metzenbaum in your December 15, 1989 letter. We hope these answers will be helpful to the committee in its consideration of this very important issue.

Yours very truly,

W S Dickinson
W. S. Dickinson
Manager

WM:dab

Attachment

JAN 18 1990

QUESTIONS FROM SENATOR JOHNSTON FOR ARCO

1. I understand that EC-1 has an RVP of 8 psi, 1 psi below California's current standard. EPA has proposed a 7.8 RVP standard for California in the summer for all gasoline, not just leaded or reformulated gasoline. If this happens, to what level will ARCO lower EC-1's RVP?

   Response

   EC-1 will meet whatever standards EPA will require for gasoline in the area that we market EC-1.

   In general, we believe that gasoline RVP should not be reduced below 8 psi. The California Air Resources Board has estimated the gasoline related emissions from both mobile and stationary sources and found that emissions reach a minimum at 8 psi and actually begin to increase at about 7.2 psi. This net increase begins to occur because (1) as the RVP of gasoline is reduced, the hydrocarbons in the vehicle exhaust increase, and (2) once the RVP reaches about 7.2 psi, the reduction in evaporative emissions from the vehicles, storage tanks, etc. is not enough to offset the increase in exhaust emissions. The State of California is in the process of adopting further controls on gasoline and has not proposed going below 8 psi.

   In addition, at some point in time, evaporative emissions will be minimized and there will be no need for RVP reductions below the RVP of the certification fuel (9 psi) after the following occurs: (1) a standard is established for running losses, (2) the summertime in-use gasoline is at the same vapor pressure that vehicles are designed and tested on and (3) most of the cars on the road are designed to minimize total evaporative emissions.

   This was confirmed when we tested EC-1 in new vehicles. We found that the evaporative emissions from these vehicles are so low that the one psi lower RVP in EC-1 did not reduce the evaporative emissions.

2. I understand that ARCO has indicated that it intends to extend the EC-1 type of reformulation to all of its gasolines in the long run. Is this true? One of the key aspects of EC-1 is its low volatility, and hence lower vehicle emissions. Do your own marketing plans for EC-X unleaded gasolines include lower volatility

than the proposed EPA standards will require?

Response

EC-1 is the first in a series of "emission control" gasolines. The next in the series will be made for use in the newer cars and its formulation will likely be different than EC-1 since EC-1 was formulated specifically for the older cars. It may be several years before the reformulated gasoline for newer cars will be available for two reasons. First, the right formula must be developed. We are participating in a joint oil/auto research program that will provide insights into a range of gasoline formulations. ARCO is also conducting independent research to try to develop a better low emission fuel. Second, substantial modifications to our refineries will be necessary to produce the required volume of fuel. The design, permitting and installation of new refinery equipment will require a lengthy period of time.

As mentioned in the response to question 1, we would not reduce the volatility of EC-X below EPA's proposed Phase II reductions since 8 psi seems to be the appropriate level. To reduce RVP to lower levels would be environmentally imprudent.

3. Most of the VOC emission reduction associated with EC-1 seems to come from the 8 RVP specification (i.e., lower evaporative emissions). With EPA's Phase II RVP controls and new vehicles designed to control excess evaporative emissions and running losses, an important way to further control emissions will be lower RVP. When will ARCO be ready to produce 8 RVP gasoline for general sale in American Society of Testing and Materials (ASTM) Class C areas (and lower RVPs in other areas)? Will ARCO be able to produce 7 RVP gasoline for general sale in Class C areas?

Response

Although the percent evaporative emission reduction from EC-1 was higher than the percent exhaust hydrocarbon reduction, evaporative emissions only accounted for about one-fourth of the total hydrocarbon emission reduction. Another important consideration is the reactivity of the volatile organic compound (VOC) emissions. In addition to reducing the mass emissions, EC-1 reduced the reactivity of the VOC emissions.

It may not be appropriate to reduce RVP to 8 psi in all Class C areas for several reasons:

- Some areas may not have an ozone nonattainment problem.
- For those areas that do have an ozone problem, it should be determined if VOC reduction is the correct approach, or whether it may be more appropriate to reduce NOx. Ozone reduction is a function of the VOC to NOx ratio in an air basin.
- There may be more cost-effective means of achieving VOC reductions than RVP reductions in some air basins.

4. Are you aware of any vehicle data showing lower exhaust VOC emissions from lower aromatics content gasoline? I understand that some aromatics such as benzene have very low reactivity, while others are higher. What indications are available that reformulated gasoline can reduce the quantity or reactivity of exhaust VOC emissions in cars with catalysts? Please submit these data for the record.

Response

EC-1 testing in non-catalytic vehicles showed lower mass VOC emissions with a lower aromatic gasoline. Enclosed is a copy of the report on EC-1.

We have also done some limited testing of EC-1 in state-of-the-art 1989 model cars and are very encouraged by the preliminary test results. The percentage reduction in exhaust emissions in the new cars is roughly equal to, or better than the percentage reductions in the old cars.

For example, limited testing on five 1989 low-mileage vehicles shows about a 12% reduction in exhaust hydrocarbons (vs about 4% in non-catalytic vehicles), about a 22% reduction in carbon monoxide (vs about 9% in non-catalytic vehicles) while nitrogen oxide emissions are cut about 3% (vs about 5% in non-catalytic vehicles). The reduction in benzene emissions in both the new and the old cars is about 40%. These new cars have very low evaporative emissions. As a result, we found no reduction in evaporative emissions from the new cars while the old cars showed an evaporative emission reduction of about 21%.

This data is preliminary and is not yet available for release.

5. I understand that olefins have high reactivity for smog formation, but are a relatively small component of the exhaust VOCs. What studies has ARCO or others performed that show the effect of fuel olefin removal on exhaust olefins and resulting atmospheric ozone? Are you prepared to remove a substantial portion of the olefins from gasoline? What effect would this have on other relevant gasoline parameters, refinery gasoline yield, gasoline cost, your other products and their costs and values to consumers?

Response

Olefins are generally highly reactive. Olefin removal/conversion to less reactive compounds may be desirable, but we not have the data to support it at this time. We are in the process of studying all potential changes to gasoline to determine the most cost-effective way of producing reformulated gasoline.

6. I understand that ARCO's EC-1 reduces benzene and aromatics in the fuel by roughly 40 percent. You state that this will reduce benzene emissions by 40-50 percent. EPA estimates that benzene emissions will represent less than a quarter of total air toxics from vehicles meeting the emission standards proposed by President Bush (and presumably a similar amount from vehicles meeting the emission standards contained in S. 1630). How does ARCO plan to control the rest of the toxics? How does gasoline composition affect emissions of 1,3-butadiene, polycyclic organics, atmospherically formed formaldehyde or toxic gasoline refueling vapors? Please explain.

Response

EC-1 in the non-catalytic vehicles resulted in about a 40% reduction in benzene and xylene emissions. Emissions of 1,3-butadiene were down about 2% and formaldehyde was up about 17%. It must be remembered that this data was for non-catalytic vehicles. We do not yet have complete speciated emission data on EC-1 in new cars with catalysts.

Mass emission reductions associated with more stringent tailpipe standards and evaporative emission controls (running losses, refueling, etc.) will also result in substantial reductions in toxic emissions, so it is not necessary to put the entire burden on the fuel.

7. You have stated that the exact composition of future reformulated gasoline (EC-X) is currently unknown. However, numerous automobile and oil industry representatives have speculated on a number of changes to current gasolines that may lower VOC emissions. These include lower aromatics, olefin and benzene levels, lower 90 percent distillation temperatures (T90), lower RVP and higher oxygen content. (a) What are your costs of each of these changes assuming all costs were assigned to gasoline, production volumes of gasoline were held constant and the production level and quality of all other products stayed the same? (b) How would each change affect refinery yield of high quality liquid fuels, refinery energy consumption, and imports of crude oil? (c) When would ARCO be ready to produce such fuels in commercial quantities?

Response

We do not have answers to each of these specific questions. However, we can say that the production of reformulated gasoline or other alternative fuels will be very expensive. For example, ARCO estimates that an investment of $1 billion at **each** of our two West Coast refineries could be required to make cleaner burning fuels.

We estimate that the production of reformulated gasoline in sufficient volume to fuel all light-duty motor vehicles will cost in the range of 5 to 15 cents per gallon more than conventional unleaded gasoline. The cost will, of course, depend on the specifications of the fuel.

8. The Department of Energy and EPA have indicated that expanded use of alternative fuels from raw materials other than petroleum will enhance our national energy security. How will reformulated gasoline enhance energy security?

Response

Reformulated gasoline will enhance energy security by maintaining a healthy U.S. fuels production industry.

Methanol is considered by many to be the leading alternative to gasoline. However, the least cost supplies of methanol would come from outside the U.S. The use of methanol would trade a dependence on crude oil imports for a dependence on a finished product, which reduces domestic manufacturing capacity. In addition to raising energy security concerns, this would worsen the U.S. trade deficit.

9. Would a rapid conversion to LPG of the light duty fleets and mass transit buses in the nine target cities improve air quality? By how much over time? How about CNG?

Response

We do not have the information to answer these specific questions. However, we can say that the conversion to LPG or CNG is a hydrocarbon control strategy. Therefore, improvement in air quality (ozone reduction) would be different for each city and would depend on the other emissions in each city. That is, ozone reductions are a function of the hydrocarbon to NOx ratio in the air basin.

QUESTIONS FOR ARCO FROM SENATOR METZENBAUM

1. You state in your testimony that you won't know what reformulated gasoline will do to the emissions of current vehicles for one year. These reformulations only represent those changes which are achievable with existing refinery configurations. Data on future vehicles and more substantial reformulations won't be available for several more years. Both government and private industry have been testing ethanol, methanol, propane, CNG, and other alternative fuels in vehicles for more than a decade. Meanwhile, in that same timeframe the oil industry has strongly resisted even small changes to gasoline, the sum of which pale in comparison to what reformulated gasoline will likely have to be in order to compete with other clean, alternative fuels. You yourself state that it was only the real threat of movement to alternative fuels that created the concept of reformulated gasoline. While you have produced EC-1, you've done it by shifting streams in your refinery. There's been no capital investment to speak of, only distribution and marketing costs. What assurances do we have that reformulated gasoline will achieve the levels of emission control available from the use of the other clean fuels and compensate for the delay you are requesting?

Response

Although public and private entities have been testing CNG, LPG, etc. for a number of years and much data has been generated, it is not the kind of data needed to determine impact on air quality. To determine the impact on ozone reduction, speciated emission data and complex air quality models are necessary. The air quality improvement benefits of M85 and other fuels have not been adequately determined at this time. The oil/auto research program will help to develop this information.

We are not asking to delay improvements in air quality. We are, however, asking government to do the following:

- Determine emission standards for fuels/vehicles.
- Establish "fuel-neutral" standards.
- Do not foreclose upon any options, e.g. reformulated gasoline.
- Let industry determine the most cost-effective way to meet the standards.

You have our assurance that we believe that if fuel-neutral, cost-effective standards are established, reformulated gasoline will be able to meet those standards. We are a fuel producer/supplier and plan to stay in that business.

2. Even if such emission reductions are achievable, what assurances do we have that the oil industry will be willing to produce the kind of fuel it will take to achieve these benefits?

Response

You have the assurance that if fuel-neutral, cost-effective standards are established, fuel producers will produce a fuel that meets those standards or go out of business. The fuels industry is very competitive. If one company is not willing to provide fuels, another will.

3. Will ARCO commit to supporting emission requirements which will require capital expenditures and operating cost increases at or below specific limits which are identified now? If so, what are these limits?

Response

ARCO is willing to commit the capital necessary to produce fuels that meet fuel-neutral standards. We are now considering an investment of $2 billion to upgrade our two West Coast refineries to produce cleaner-burning fuels.

However, in order to make that kind of commitment, we need some assurance that we can get the necessary permits and be able to operate the new equipment for a long enough period to recover our investments.

Although reformulated gasoline has significant potential as an emission control strategy, its potential will not be realized unless the fuels industry is able to obtain the necessary permits to construct and operate the new processing units that will be required to produce this new fuel. Under the current Clean Air Act it is very difficult and time consuming to obtain permits in nonattainment areas. We are concerned that with the additional permitting requirements included in S. 1630, the current very difficult system will become almost impossible.

Consideration should be given to providing emission offsets for facilities that produce low emission products such as reformulated gasoline. Reasonable further progress toward attainment would, of course, have to be maintained.

We do not know the specific limits that will be required. Government, with input from the regulated community, should establish equitable standards.

4. Please compare the environmental and public health effects of an accidental tanker spill of gasoline and methanol in marine and inland water environments. How about on land?

Response

Methanol is completely soluble in water and moves easily through soil to groundwater, thus making drinking water contamination a concern. Due to its solubility with water, methanol is likely to travel farther and faster in groundwater than gasoline. This is of particular concern due to its human toxicity and lack of distinctive odor and taste to aid detection by humans. Methanol is not, however, persistent in the underground environment. It will tend to disperse in the groundwater and ultimately will disappear through biodegradation. The time needed to accomplish this will be highly specific to the site and the magnitude of the spill. In all cases, however, it will be detectable underground for a long time.

Methanol would impact different species in the environment than gasoline since hydrocarbons float on the water and methanol is soluble.

A large spill or leak of methanol into surface water bodies will require a different emphasis on the emergency response strategy employed than used with spills of hydrocarbon materials. Containment and recovery will be impossible in most cases, so the emphasis will be on warning potentially-impacted people in the path of plume movement and monitoring the progress of the dispersion of the material -- much like is done following a cloud of toxic gas released into the air. This is particularly vital if the water body is used as a municipal water supply. Conventional

GENERAL MOTORS CORPORATION
1660 L STREET, N. W.
WASHINGTON, D.C. 20036

February 26, 1990

The Honorable J. Bennett Johnston
United States Senate
136 Senate Hart Office Building
Washington, D.C. 20510-1802

Dear Senator Johnston:

I apologize for the delay in responding to the follow-up questions you provided for GM's witness, Joe Colucci, subsequent to the November hearing of the Senate Energy Committee on alternative fuels. Attached are the General Motors answers to those questions. I hope you will find the information helpful.

Sincerely,

Mark Kemmer
Mark L. Kemmer

MLK/cjl

cc: Joel Saltzman, Senate Energy Committee staff

QUESTIONS FROM SENATOR JOHNSTON FOR GENERAL MOTORS

1. What is the potential for air quality improvement of optimized CNG and LPG vehicles?

A: On a per vehicle basis, optimized CNG vehicles offer potential for significant ozone air quality benefits in comparison to current gasoline-fueled vehicles. This potential arises because the emissions from CNG-fueled vehicles contain little if any reactive hydrocarbons and aldehydes. Because of their extremely low emissions of aldehydes, CNG vehicles also offer, on a per vehicle basis, ozone air quality benefits compared with methanol-fueled vehicles. Carbon monoxide air quality benefits are also likely with CNG compared with either gasoline or methanol on a per vehicle basis because CNG provides much easier cold starting than either of the other two fuels, and most CO is produced during cold starting.

The real issue regarding air quality benefits from CNG is not how much improvement can be made on a per vehicle basis. Instead, the real concern is how many vehicles are needed to replace sales of either gasoline- or methanol-fueled vehicles for an air quality benefit to be measurable in a given urban area. This number could be very large because the absolute differences in emissions among new vehicles fueled by different fuels is growing smaller as technology continues to improve.

Optimized LPG vehicles, on a per vehicle basis, will not be as clean as CNG vehicles, and they will be very similar in air quality improvement potential to current gasoline-fueled vehicles. Furthermore, in contrast to CNG where supply is considered adequate, LPG supplies are constrained and will limit its utilization.

2. Can the automakers take advantage of higher octane properties of CNG and LPG to build higher compression, more efficient engines? What improvements could be expected in operating costs?

A: If automakers were to design engines optimize for CNG or LPG, they could take advantage of the higher octane to obtain efficiency improvements by increasing the compression ratio. However, these improvements will have to be traded off against the potential for higher HC and NO_x emissions, both of which increase with higher compression ratios. The higher HC emissions will be more troublesome with LPG than CNG, because LPG produces reactive HC emissions. However, the higher HC emissions with high compression ratio CNG engines will also be troublesome if future emissions standards recognize total HC emissions rather than reactive HC emissions.

Engines fueled with either CNG or LPG could have lower operating costs for two reasons: lower fuel cost compared with gasoline and lower maintenance costs. Lower fuel costs currently apply; however, we do not know if the cost will still be lower if the demand for CNG or LPG rises and the demand for gasoline decreases. Maintenance costs with CNG or LPG are likely to be lower than with gasoline in areas such as oil changes and spark-plug replacement. However, at the present time, we are not able to determine accurately the total operating cost benefits of either CNG or LPG over gasoline.

3. **How much improvement may there be from automakers to reduce evaporative, running loss, hot soak, and diurnal emissions?**

A: "Evaporative emissions" consist of four basic elements or categories:

1) Diurnal;
2) Running losses;
3) Hot soak; and
4) a newly identified source, Resting losses

The largest reductions in these evaporative emissions are achieved by control of fuel volatility. The EPA implemented Phase 1 of its volatility control regulations, limiting summer volatility to 10.5 RVP in Class C areas in the summer of 1989. Phase 2, controlling volatility to 9.0 RVP, is anticipated soon and will offer substantial additional reductions.

The measure of evaporative emissions, and the amount of improvement that automakers can achieve, is a function of the test procedure. In November 1989, General Motors proposed a new "environmentally based" real-time evaporative emission test procedure to both the EPA and CARB. This procedure defined new, more stringent measures of diurnals, running losses, and hot soaks and identified a previously uncontrolled source, "resting losses".

Significant improvements are anticipated in future evaporative emission levels, provided that Phase 2 volatility controls are adopted and continued improvements are made in vehicle design.

Work is underway to provide quantitative test results for the current fleet of vehicles and estimate the potential for future improvement using these more stringent procedures. These investigations are too preliminary to quantify the room for improvement with any precision. Estimates, however, can be made.

Running losses can be controlled to zero with 9.0 RVP fuel under 95°F summer conditions.

Future test procedures will address diurnal emissions resulting from multiple day parks. Emissions from the second, third and subsequent diurnals will be reduced. The magnitude of the improvement will probably be large.

Early estimates suggest that resting losses are the largest remaining component of evaporative emissions, once fuel volatility is controlled to 9.0 RVP. Resting losses are the constant losses of hydrocarbons that result from permeation through the non-metallic fuel system components. While the hourly values are small, they occur 24 hours a day and result in significant, if not the largest, contribution to the daily inventory of evaporative emissions. Design and material specification improvements offer the potential for large reductions in resting losses.

Little improvement in hot soak emissions is anticipated. Today's fuel-injection vehicles effectively control hot soaks to very low levels with 9.0 RVP fuel.

4. What is the status of efforts to remedy the cold start problems of alcohol fuels?

A: Extensive research and development conducted in the past few years has been successful in improving cold starting with M85 (85% methanol) fuels. The improvements have resulted from significant changes in engine hardware, changes in the amount of fuel injected into the engine during cold starting, and careful attention to the volatility of the M85 fuel. Laboratory engines have started on M85 down to -20°F, but not as reliably as desired. Additional work is underway to insure that our variable-fueled vehicles will start reliably on M85 down to -20°F or lower.

Application of technology used to improve cold starting on M85 does not substantially improve cold starting on M100 (100% methanol). Cold starting remains a major obstacle to the use of M100 fuel in vehicles.

5. Will the automakers be able to develop long-lasting catalysts that address formaldehyde and NO_x emissions in alcohol-fueled cars?

A: General Motors is optimistic that we will be able to develop long-lasting catalysts that reduce formaldehyde emissions from alcohol-fueled cars. We, and our catalyst suppliers, are doing research to develop such catalysts, and progress is being made. The durability of the current technology catalysts will be tested in the 2200 variable-fueled vehicles that GM is providing to California in the next two years. These vehicles will use primarily M85 fuel, and we will closely monitor catalyst performance to provide feedback to our researchers.

6. Will the automakers be able to develop catalysts that burn up aromatics and other air toxics and potential VOCs? Can automakers appreciably improve combustion characteristics to reduce these emissions? Is reducing these emissions a less expensive job for refiners or automakers?

A: We are optimistic that GM, working with our catalyst suppliers, will be able to develop future catalysts that will selectively burn up species, such as total and specific aromatics (benzene) and other air toxics. We are not as optimistic that we can improve appreciably engine combustion characteristics to reduce specific emissions entering the catalytic converter. In large part, the fingerprint of the hydrocarbon species leaving the engine matches that of the hydrocarbons in the gasoline.

We expect to obtain a significant amount of data on these issues from the work being done on the Auto/Oil Program to improve air quality. That program could also provide information on whether it is more or less expensive for refiners or automakers to reduce these emissions. However, in making these cost comparisons, one should recognize that changes made by the automakers affect only those new model vehicles incorporating the changes, whereas changes to gasolines made by refiners can reduce emissions from all vehicles using the gasoline. This includes the older vehicles in our nation's fleet, the ones responsible for most of the vehicular contribution to air pollution.

QUESTIONS FROM SENATOR METZENBAUM FOR GENERAL MOTORS

1. If the refiners made a gasoline that has low volatility and aromatics, could GM build a car that significantly reduced evaporative losses and increased fuel economy so that we could reduce smog and air toxics to acceptable levels nationwide without moving to alcohol-fueled cars? If mass produced, how much would it cost per vehicle?

A: Gasolines with low volatility and low aromatics offer considerable promise for reducing vehicle emissions. The auto industry is currently cooperating with the petroleum industry to determine the emissions and air quality benefits of reformulated gasolines. Aromatic content and volatility are two of the gasoline parameters being investigated. The results of the study will apply to current vehicles as well as to future gasoline-powered vehicles (prototypes are included in the second phase of the program). Not only regulated emissions, but also air toxics will be measured.

The beauty of modifying gasolines to reduce vehicle emissions is that the benefits apply to all vehicles using the reformulated gasoline — existing as well as new vehicles. This provides great leverage, especially in cities not in compliance with air quality standards, because the older vehicles are the greatest contributors to vehicle-derived emissions.

General Motors will use the results of the auto/oil program to help design future gasoline-fueled vehicles with reduced emissions (exhaust and evaporative). We are also working to reduce emissions from alcohol-fueled vehicles. Thus, until the data are in hand, we will not know which route is preferable. Both may be necessary to meet the needs of specific urban areas.

Fuel economy with gasolines with low aromatic content is likely to be lower on a per gallon basis than with current gasolines. This is because aromatics are the highest energy-containing components in gasoline on a volumetric basis. On a per energy unit basis, gasolines with low aromatic content should perform equally well as current gasolines. Data on both volumetric and energy bases will be obtained for all of the fuels being tested in the auto/oil program.

At present, we are unable to state how much more or less it would cost to mass produce vehicles designed for low aromatic, low volatility gasolines. It is likely, however, that cost increases would be less than those expected to mass produce alcohol-fueled vehicles.

2. What percentage of GM's 1989 and 1990 fleets need premium or mid-grade gasoline? Which GM cars perform better when they use premium? By how much?

A: Starting with the 1990 model year, GM has recommended the use of premium unleaded gasoline for all of its Cadillac models. Previously, it had been recommended for Corvettes. Also, we have said in our owners' manuals that cars equipped with our 5.0L and 5.7L engines could, at the owner's choice, use either premium or other unleaded gasoline. This option was provided because these engines as installed in Camaros and Firebirds contain knock sensors. In these cars, the owners could decide between either improved acceleration performance with the higher priced premium fuel or conventional acceleration performance with the lower priced regular or mid-grade fuels.

Considerably less than 10% of GM's 1990 production cars require premium unleaded gasoline. None of our light-duty trucks require premium. Essentially, all of the cars requiring premium are Cadillacs, which do not have knock sensors. Their engines are tuned to achieve optimum fuel economy with premium. Other vehicles with knock sensors will generally see a one second reduction in 0-60 mph acceleration time if their owners' opt to use premium gasoline.

3. Mr. Colucci stated at the hearing that some increased efficiency and performance gained in some GM models from using premium fuel must be weighed by consumers against the added cost of premium fuel. How much better is the performance? Does the increase justify the added cost per gallon of premium? Please quantify your answers.

A: The question of whether or not the increased performance of knock-sensor equipped cars using premium gasoline (detailed in our response to question 2 above) justifies the added cost of the fuel is not readily answerable. It is easy to quantify the increase in fuel cost. It is not easy to quantify on a cents per gallon basis the pleasure that the driver gets from a more responsive vehicle.

4. Why do you think that so many new car buyers are using premium, and should they?

A: Many buyers are using premium unleaded gasoline in cars that do not need its higher octane quality. They perceive that premium is an all-around better fuel than regular, and this perception may be a function of gasoline advertising. The primary difference between premium and regular gasoline is octane quality. Using premium in an engine whose octane quality is satisfied by a lower octane fuel, and which is not equipped with a knock sensor, provides no benefits to the engine or to fuel economy. Some marketers' premium fuels contain better detergent packages than their regular fuels, and customers may purchase premium for this reason as added "insurance" to guard against deposit formation in fuel systems and engines.

5. Do octane requirements in GM cars increase for a given engine over time? Please explain. If so, can motorists use fuel additives to remedy any such problems? What products would GM recommend, how often should they be used, and how much do they cost at retail? Are there other recommended maintenance remedies?

A: Octane requirements in all gasoline-fueled spark-ignition engines increase gradually with mileage until they stabilize at roughly 10-20,000 miles. This fact is well documented, and octane requirement increases also occurred with leaded gasoline. The increase is a result of deposit formation in the combustion chamber. The "insulation" causes higher combustion temperatures that increase the engine's octane requirement. This phenomenon is well known to engine designers, and they accommodate it in their engine calibration.

Some aftermarket additives can temporarily reduce engine octane requirements. GM does not recommend their use. Instead, we recommend that owners adjust the octane of the gasoline they use if knock is troublesome. This can be done by using a higher octane fuel (either mid-grade or premium) or by blending fuels at self service pumps.

6. Is it the opinion of GM that, for its cars designed to operate on regular unleaded gasoline, there are any additives blended into mid-grade or premium gasolines sold by the major gasoline marketers that improve the life, cleanse, protect, or otherwise benefit the car above and beyond that contained in regular unleaded? Are any increased concentrations of any additives that may be blended into mid-grade or premium unleaded fuels sold by major gasoline marketers better for GM cars than the concentrations added to their regular unleaded fuels?

A: General Motors believes that all grades of a given marketer's unleaded gasoline should contain the same concentration of an effective gasoline detergent package. We have encouraged gasoline marketers in this direction. However, they determine their own gasoline additives, and some put greater concentrations of a detergent additive package in premium than in regular unleaded gasoline. We would like to see all of our engines given equal cleanliness protection by gasoline marketers.

DEPARTMENT OF AGRICULTURE
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20250

November 3, 1989

Honorable J. Bennett Johnston
Chairman, Committee on Energy
and Natural Resources
United States Senate
Washington, D.C. 20510-6150

Dear Bennett:

In your October 25, 1989 letter you indicated the Committee on Energy and Natural Resources is planning to hold a hearing on alternative fuels, including ethanol, and the implications for energy policy and energy security.

You asked the Department of Agriculture to provide answers to some important questions concerning the agricultural consequences of shifting from gasoline to ethanol in a substantial way. Our response is enclosed.

The enclosed questions and answers illustrate that ethanol fuel from agricultural feedstocks is a complex issue with both positive and negative impacts. A number of the problems restricting use of ethanol fuels have been overcome. ETBE dramatically improves ethanol's fuel properties, increasing its acceptance in the marketplace.

The United States has idle farmland. We have substantial capacity to produce feedstock for ethanol fuel, protect our land resources, and still continue to meet the food needs of the Nation and serve our foreign markets as well. Ethanol benefits agriculture, helps reduce harmful automobile emissions and reduces our dependence on imported petroleum. Under certain circumstances, increases in ethanol production can produce savings in agricultural program costs that exceed the cost of ethanol subsidies.

Ethanol cannot meet all of our alternative fuel needs. Much larger increases in ethanol production than the production scenario set forth in the enclosed responses would tax our agricultural resources, raising food and fuel costs. But, some expansion of ethanol production is likely to be in the best interests of agriculture and the Nation. We support expanding ethanol research, expanding the ethanol fuels program to the year 2000, and broadening the program to include ethanol used to make ETBE.

Sincerely,

Clayton Yeutter
Secretary

1 Enclosure

Responses to Questions of Senator J. Bennett Johnston

Several assumptions were made to prepare responses to the questions. These assumptions include the following:

- Ethanol production will use corn feedstock.
- Each bushel of corn yields 2.5 gallons of ethanol.
- One-half of ethanol will be produced using a dry-milling process and one-half will be produced using a wet-milling process.
- Ethanol production will increase as shown in the following table:

	Amount of alternative fuel needed for proposed alternative neat-fuel vehicles		Fuel needs in absence of neat-fuel vehicles	
Year	Methanol	Ethanol 1/	Gasoline	Ethanol in ETBE 2/
		Billion gallons per year		
1995	.500	.375	115	.436
1996	1.250	.938	115	1.090
1997	2.250	1.688	115	1.961
1998	3.250	2.438	115	2.832
1999	4.250	3.188	115	3.703
2000	5.020	3.765	115	4.373
2001	5.790	4.343	115	5.045
2002	6.560	4.920	115	5.715
2003	7.330	5.498	115	6.386
2004	8.100	6.075	115	7.057
2005	8.870	6.653	115	7.728

1/ The amount of ethanol consumed was assumed to be equal to 75 percent of methanol consumption (this assumes the same number of miles per Btu of energy in the two fuels).

2/ Assumed a goal of 16 percent blends of ETBE in gasoline, and assumed that ethanol represents 42 percent of the volume of ETBE. Since it would not be possible to produce such large quantities of ethanol for ETBE immediately, ETBE use was phased in at the same rate that neat ethanol was assumed to be phased in for the alternative-fuel vehicles in the President's Clean Air Proposal.

Sources: Estimates for methanol and ethanol used by neat-fuel vehicles were obtained from EPA. Gasoline consumption estimates for 1995-2000 were based on DOE's Annual Energy Outlook and consumption was assumed to continue to remain constant between 2000 and 2005.

Question 1--

a. How much land would have to be cultivated to produce feedstock for ethanol if it became the sole alternative fuel for the President's Clean Fuels Program in 1995? 2000? 2005? What percentage increase in land under cultivation would this represent?

A small change in total cultivated acres would be expected. Much of the land necessary for additional ethanol production would be land formerly planted in soybeans. Soybean acres would fall because the byproducts associated with ethanol production (DDGS or corn gluten feed, meal, and oil) compete with soybean meal and oil. Additional ethanol byproducts would put downward pressure on soybean meal and oil prices causing farmers to switch from soybean to corn production. As a result of the switch from soybeans to corn coupled with the assumption that additional ethanol production is phased-in over time, there is a negligible change in total cultivated acres in 1995, an increase of about 2.5 million acres in 2000, and an increase of almost 3 million acres by 2005. Corn acres would be about 6 and 8 million acres higher in 2000 and 2005 while soybeans acres would fall by about 5 and 10 million acres in 2000 and 2005, respectively. Wheat acreage would increase by about 3 million acres while sorghum would increase by about 1 million acres.

In all years this increase in land under cultivation represents less than 1 percent of total land under cultivation.

b. What would be the net reduction in CO_2?

Ethanol fuel has the potential to reduce CO_2 emissions compared to gasoline because the CO_2 released when ethanol is burned is recaptured when corn or other plants are grown as ethanol feedstocks. In reality, the issue is more complex because fossil fuels are used to grow and harvest the corn, and to convert the corn into ethanol. We estimate that some 75,000 to 95,000 Btu of fossil fuel energy (mostly coal) generally is used as an energy source to produce a gallon of ethanol. The issue is further complicated because ethanol has higher octane and lower energy density than gasoline and because ethanol byproducts are involved. Based on overall energy balances and previous studies by the Congressional Research Service and the Tennessee Valley Authority, we have assumed that ethanol from biomass contributes less CO_2 per gallon of fuel than does its gasoline equivalent.

EPA reached a different conclusion when it recently examined the available literature and conducted its own assessment of this question. The draft EPA report (David Bartus, "Effects of Fuel Ethanol Production and Use on CO_2 Production and Emissions," Draft Technical Report, Office of Mobile Sources, June 1989) concluded "use of ethanol as a motor fuel in gasohol is not likely to yield any significant reduction in net CO_2 emissions. A number of uncertainties in the quantity of CO_2 emissions from various stages in the ethanol manufacture and in the influence of ethanol use on refinery operations and hence refinery energy use and CO_2 emissions may indicate either a net increase or decrease in CO_2 emissions from ethanol fuel use compared to gasoline" (page 32).

Improvements in energy efficiency in ethanol plants, e.g., membrane technology, and in farming are likely to result in a reduction in CO_2 emissions compared to gasoline in the future, although we are not able to predict when or the magnitude of the benefit.

c. What would be the soil conservation impacts?

For the period through 2005, we expect that corn will continue to be the major feedstock for producing ethanol from biomass sources. Corn acreage will increase to meet greater ethanol demand. This acreage likely will come largely from reduced soybean plantings as the ethanol high protein byproducts compete with soybean oil meal depressing both meal and soybean prices. To the extent that additional acreage is necessary for ethanol production, hayland probably would be shifted to corn.

The soil conservation impacts of increased corn production with a shift from soybeans to corn are minimal. Corn may have slightly better potential to restrict water erosion than soybeans. Any substantial acreage shift from hay crops to corn will increase soil erosion. A substantial shift from soybeans into corn will disrupt the typical rotations of corn and soybeans or corn, soybeans, and hay. A continuous corn monoculture may have deleterious effects on the soil.

When ethanol from cellulose becomes competitive with that from corn after 2010, acreage devoted to tree production would not have the erosion potential of row crops.

The degree to which conservation compliance would insure protection of erodible cropland used for corn would need to be explored. Cropland not subject to compliance may be somewhat more subject to erosion risks since a conservation system is not required in order to maintain USDA program benefits.

Question 2--

a. If the EPA decided to mandate oxygenating all gasoline with 15-17 percent ethyl tertiary butyl ether (ETBE) which uses ethanol as a feedstock, to solve the clean air problem, what would your answers to question 1 be? What percentage increase in land under cultivation would this represent?

A small change in cultivated acreage would be expected for the same reasons given in response to question 1. However, the magnitudes are slightly larger given the added ethanol needed. There would be a negligible change in total cultivated acres in 1995, an increase of about 3.0 million acres in 2000, and an increase of almost 3.3 million acres by 2005. Corn acres would be about 7 and 9 million acres higher in 2000 and 2005 while soybean acres would fall by about 6 and 13 million acres in 2000 and 2005, respectively. Wheat acreage would increase by about 4 million acres while sorghum would increase by about 1 million acres.

In 1995 the change would be negligible. In 2000 and 2005, the increase in land under cultivation represents slightly over 1 percent of total land under cultivation.

b. What would be the net reduction in CO_2?

See question 1 above.

c. What would be the soil conservation impacts?

Our response would be similar to the answer to question 1. Again, changes in total cultivated acres are not much different.

Question 3—

a. What would you estimate as the costs of production of ethanol and ETBE to implement the Clean Fuels Program in 1995? 2000? 2005?

Cost of producing ethanol will change for several reasons.

- First, added ethanol demand will increase corn prices and therefore ethanol feedstock costs will increase. By 2005, corn prices would increase by over $0.50 per bushel under both scenarios. This change in corn prices would increase the cost of ethanol production by $0.20 per gallon.
- Second, added ethanol production will generate greater amounts of byproducts (DDGS or corn gluten feed, meal, and oil). Larger byproduct supplies will cause prices to fall. Based on estimated changes for soybean meal, we estimate that the value of ethanol byproducts could fall by 50 percent.
- Third, significant increases in ethanol production (over 1.5 billion gallons per year) will necessitate construction of new plants, thereby increasing investment costs. Capital charges could increase from $0.19-$0.29 per gallon if only incremental addition to an operating wet mill was necessary, to $0.38-$0.48 per gallon in order to construct a new plant.
- Fourth, new state-of-the-art plants could reduce operating costs. Average operating expenses could fall from $0.47 per gallon of ethanol produced to $0.38 per gallon in state-of-the-art plants.

Considering these factors, added costs of ethanol production from higher corn costs, lower byproduct values, and higher capital costs outweigh the additional savings from lower operating costs. Total production costs could increase by over 40 percent by 2005.

b. The cost of producing ETBE depends on the price of ethanol and isobutylene feedstocks—a gallon of ETBE is obtained by reacting 0.42 gallons of ethanol with 0.68 gallons of isobutylene. A recent report by ARCO Chemical Company shows that when ETBE is produced commercially, processing costs (excluding feedstocks) would be about $0.12 per gallon of ETBE. With current ethanol and isobutylene prices (about $1.10 per gallon and $0.54 per gallon, respectively) the total cost of producing ETBE (including a 15-percent profit) would be about $0.95 per gallon of ETBE. The cost would drop to about $0.70 per gallon if the Federal ethanol tax credit were available to the ethanol used to produce ETBE. Costs of producing ETBE in the future are uncertain. Processing costs may increase with inflationary forces and or fall with improvements in production technology. According to the author of the ARCO report, isobutylene prices depend on the price of unleaded gasoline, the price of butane, and the value of octane. Butane (and, in turn, isobutylene) supplies may increase and prices fall due to lower gasoline volatility requirements imposed by EPA. However, the Department of Agriculture has no basis for projecting these cost factors. If ethanol prices were to increase by 40 percent as estimated in the first part of this question, ETBE production costs could rise by $0.19 per gallon, unless offset by lower isobutylene costs.

c. What would be the impacts of "ethanol" and "ETBE" on farm costs of production?

	Added farm costs: 1/	
	2000	2005
	Million dollars	
Neat ethanol scenario:		
Total costs		
Corn	$1,273	$1,906
Soybeans	-599	-1,347
Total	673	559
Fuel expenditures		
Corn	125	171
Soybeans	-48	-93
Total	77	78
Fertilizer expenditures		
Corn	327	503
Soybeans	-32	-84
Total	295	419
ETBE scenario:		
Total costs		
Corn	1,494	2,220
Soybeans	-714	-1,600
Total	781	600
Fuel expenditures		
Corn	146	200
Soybeans	-57	-111
Total	89	89
Fertilizer expenditures		
Corn	384	586
Soybeans	-39	-100
Total	345	486

1/ Because very little additional ethanol is produced in 1995, only results for 2000 and 2005 are presented.

d. Ethanol, ETBE and gasoline can all be stored for approximately the same cost—about $0.005-$0.0075 per gallon ($0.21-$0.31 per barrel). This assumes a one month storage turnover in a break-bulk operation where the product is delivered in huge volume (for instance, by barge or pipeline) and shipped out in smaller quantities. This cost is not expected to increase through 2005.

Transportation costs are dependent on the mode of transportation (truck, rail, barge or pipeline) and the distances product is shipped. Pipeline shipment is the least-cost method, but is not available for water-soluble ethanol because pipelines currently are managed as wet systems. Pipeline shipment would cost approximately $0.015 per gallon ($0.63 per barrel). Barge shipment, the next least cost transportation alternative, may cost up to $0.05 per gallon ($2.10 per barrel). This is a likely method of shipment, given the current locations of major ethanol and petroleum companies. Rail is the most expensive large-volume shipment method with rates determined by Interstate Commerce Commission tariffs. Shipment from Decatur, Illinois to Wichita, Kansas, a distance of about 700 miles, costs about $0.10 per gallon ($4.20 per barrel). Truck transportation would be used mostly on a local basis since costs are very high and volumes are relatively small (a typical minimum is 40,000 pounds, which is 6,000 gallons or 145 barrels). For example, the cost to ship a 40,000-pound load for 500 miles is $0.23 per gallon or $9.84 per barrel.

These costs generally include loading and unloading, leasing hoses, and a limited amount of loading time. The need for additional loading time, pump rental, extra hoses or other special services can increase transportation costs.

Question 4--
Should ethanol for ETBE receive the same tax credit as is currently available for ethanol as a constituent in motor fuel? Please explain in detail.

We believe that ethanol used to produce ETBE should be granted a tax credit equal to that of ethanol blended directly with gasoline.

An analysis of ETBE to date suggests it has superior qualities to ethanol directly blended with gasoline. ETBE is fungible with gasoline and other petrochemical-based octane enhancers, making it more acceptable to oil companies and consumers. It can be blended with gasoline at the refinery and distributed throughout the country through the existing infrastructure. Ethanol, on the other hand, requires costly special handling and transportation and is blended with gasoline only at distribution centers close to retail stations. As a result, the bulk of the ethanol-blended fuel is sold in the Midwest. Ethanol is sold primarily in States which offer a State subsidy in addition to the Federal excise tax exemption. It appears that the Federal subsidy alone would be sufficient for ethanol that is made into ETBE, permitting it to penetrate national fuel markets. Environmentally, ETBE has certain advantages. It can reduce carbon monoxide and ozone pollution from motor vehicles. It permits the reduction of some of the more noxious components of gasoline which are added to increase octane.

Unpredictable factors could make the current $0.60 per gallon Federal subsidy excessive, insufficient or unnecessary. If Congress chose to mandate the use of ethanol or ETBE, a subsidy would not be needed since consumers would have to pay whatever price is necessary to obtain the fuel. If, on the other hand, a subsidy was used to induce demand, the amount of the subsidy would be contingent on oil and grain prices—which cannot be predicted. Additional ethanol production would drive up the price of corn and depress the price of byproducts, necessitating larger subsidies to reach the levels of production contemplated. It is important to note that ethanol prices, in the absence of a mandate, are determined by oil prices, not by the costs of ethanol production.

Question 5—
What would be the impacts on the price of corn? Sugar cane? Fertilizer? Farmland? Farm machinery?

a. Impacts on corn prices?

Under the "ethanol" scenario, corn prices could increase by 25-30 percent by 2005. This represents an increase in corn prices of about $0.02 per 100 million bushels of added corn demand.

Under the "ETBE" scenario, larger amounts of ethanol are required. Therefore, corn prices could increase by over 30 percent by 2005. This represents an increase in corn prices of $0.02-$0.03 per 100 million bushels of added corn demand.

Soybean and cotton prices could fall by as much as 20 percent under both scenarios because of the added ethanol byproducts: distillers dried grains (DDGS), or corn gluten feed, meal, and oil would compete against soybean and cotton seed meals, and oils.

b. Impacts on sugar cane?

No analysis of the sugar cane market was conducted, but little impact is expected.

c. Impacts on fertilizer?

Both plans could have a significant impact on fertilizer use and prices because of the switch from soybeans, a relatively small user of fertilizers, to corn, which requires a relatively high level of fertilizer use. Under the "ethanol" and "ETBE" scenarios, fertilizer use could increase by as much as 400,000-500,000 tons per year, respectively. These changes reflect a 2-percent increase in total fertilizer use in agriculture.

d. Impacts on farmland?

Changes in farmland values should be relatively small at the national level because overall agricultural production changes are relatively small. As a result, changes in the demand for farmland and farmland prices will be small. Regionally, the results depend on the ability of farmers to switch from soybeans and cotton into corn production. Land values would tend to increase in the Corn Belt, but could decline in the Southeast and Delta States.

e. Impacts on farm machinery?

Because overall agricultural output is not expected to change significantly, limited impacts on farm machinery prices would be expected.

Question 6--
Would the ethanol or ETBE necessary to implement the President's Clean Fuels Program by 1995, 2000, and 2005 be cost effective if produced domestically? From foreign source? From a combination of sources?

a. Ethanol from corn in the U.S. is not expected to be cost effective with gasoline until oil prices reach about $40 per barrel. With the current Federal subsidy of $0.60 per gallon or $25.20 per barrel, ethanol can compete with $15 oil. Oil prices have ranged from $15-$20 over the past year and are expected to remain relatively low through year 2000 (DOE's mid-range price is $28 per barrel). Thus, subsidization of ethanol is expected to be necessary for the next decade barring unforseen price changes.

Domestic ethanol from biomass sources other than corn are even less cost effective. However, researchers at DOE and USDA continue to improve the processes for converting cellulose and lignocellulose from wood into ethanol. If they are successful, wood could potentially displace corn as the principal ethanol feedstock, possibly, without subsidy. This technology, however, is not expected to be commercially available before 2010.

Foreign supplies of ethanol from biomass sources offer little hope for being more cost competitive. Estimates of total cost of ethanol from Brazilian sugarcane range from $0.95-$1.12 per gallon--$40-$47 per barrel plus transportation to the States. Currently, Brazil is reducing ethanol production and devoting more cane to producing raw sugar. This raises the question as to dependability of supply. Additionally, some U.S. produced ethanol now is being marketed in Brazil to meet their ethanol demand.

Ethanol from indigenous feedstocks in the Caribbean Basin Initiative nations likely would be more costly than Brazilian ethanol largely because of lack of economies of scale and less optimum growing conditions.

Studies on the cost of ethanol production in the European Economic Community indicate that ethanol from wheat may be nearly double the cost of ethanol from corn in the United States. At present, there is excess wine alcohol in Europe but the volume is limited and once these supplies are used may not be rebuilt.

A potential additional source of ethanol is from ethylene. Petroleum analysts indicate a growing overcapacity of refining capability to produce ethylene. This additional ethylene capacity is widely dispersed around the world, including the United States. Ethylene production is expected to increase some 6 million metric tons by the early 1990's. Analysts expect such production to drop prices from the current $0.28-$0.29 per pound to $0.13-$0.15 per pound in the 1990's. If the additional production was converted to ethanol, this source could approximate 3 billion gallons per year. However, ethanol made from petroleum products is not eligible for the Federal excise tax exemption or the blender tax credit under existing law.

b. What would be the effects on the balance of trade?

Trade in a large number of products could be affected by an ethanol program under the Clean Air Act including petroleum, ethanol, animal feeds, feedgrains, oilseeds, and, indirectly, most other exports.

Ethanol use reduces demand for both domestic and imported petroleum. Any resulting reduction in petroleum prices would cause the domestic producers' share of the U.S. oil market to decline. U.S. oil companies generally pump at a relatively steady rate so short run changes in demand are accommodated by adjusting imports. Thus, the initial effect of a reduction in oil demand would be to reduce oil imports rather than domestic production. But, lower oil prices also will reduce U.S. drilling activity, thereby reducing long run production capacity. Over time, lower oil prices erode U.S. production and increase imports. While ethanol production would reduce oil imports in the short run, the long run effect is uncertain.

Ethanol imports would increase throughout the period if not otherwise restricted by law because increased ethanol demand will increase its price, making the U.S. an attractive market. There would be no ethanol exports because of high domestic demands, resulting in a negative balance of ethanol trade.

Ethanol byproducts substitute for other protein-rich animal feeds, such as soybean meal, and also can replace feedgrains. Massive ethanol production would vastly increase the amount of byproducts available. New markets would need to be found. The European Community, currently the principal export market for byproduct feeds, cannot be counted on to absorb additional amounts of the byproducts. The USSR represents a potentially large market but a number of obstacles limit our potential to make large commercial sales to that country. Few other countries have a livestock industry based on feeding high-protein feeds. Sharply lower byproduct prices would stimulate exports, but it is uncertain how much byproduct volume would be exported and what the effect would be on export revenues.

Grain trade also would be affected. Between 1973 and 1987, 26.5 percent of corn production was exported. As ethanol production increases corn prices, export sales would be expected to fall. The actual impact will depend on world grain production and prices, but the overall effect on U.S. grain trade would be negative. Exports of soybeans and soybean meal could increase due to lower prices. It is not possible to estimate the net effect of additional ethanol production on the balance of trade.

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